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Pottery and Prehistory of Black Fox Island: Technical patterns in a cultural perspective

by

Kathleen Connor Learn

(C)

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Arts

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Pottery and Prehistory of Black Fox Island: Technical patterns in a cultural perspective submitted by Kathleen Connor Learn in partial fulfilment of the requirements for the degree of Master of Arts in Anthropology.

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Date..October 7, 1986.....

Abstract

Part of a pottery vessel was recovered from site GfPa-32 in the southern boreal forest of Alberta. The vessel had been previously assigned to the Clearwater Lake Punctate type found throughout the boreal forest of Saskatchewan and Manitoba, and thought to be of Cree affiliation. Further analytical evaluation of the vessel showed that, based on the established typologies, the vessel is closer to late variant Saskatchewan Basin ware of the southern Alberta plains and parkland. It has, however, been proposed that Clearwater Lake Punctate and Saskatchewan Basin ware may be historically related.

Analyses of the vessel (Pot 1) were conducted to observe its technical background. An analysis of the probable techniques used to form it resulted in a reconstruction or interpretation of the process of vessel manufacture. Literature descriptions of Clearwater Lake Punctate and Saskatchewan Basin ware pottery were evaluated and used to arrive at a generalized reconstruction of those techniques of manufacture. It was concluded that the Clearwater Lake Punctate and Saskatchewan Basin ware manufacture processes were similar. This conclusion provided encouraging support for the theory that Clearwater Lake Punctate and Saskatchewan Basin ware are related.

Chemical analysis using INAA was conducted for Pot 1 and several samples of clay from BFI to see if Pot 1 may have been made of local clay. The data indicated that

another source of clay had been used. Mineralogical analysis of Pot 1 showed that it contained granitic temper, a technical correlate with CLP and SBW.

The author concludes that there is ceramic evidence for a connection between site GfPa-32 and the southern Alberta plains. A suggestion of dynamic interplay between the cultural groups currently archaeologically represented by Clearwater Lake Punctate ceramics and Saskatchewan Basin complex ceramics is supported by the preliminary foray into technological analysis outlined in this thesis. Further study into the issue of boreal forest, parkland and plains cultural dynamics, particularly with regard to the currently recognized Clearwater Lake Punctate of Saskatchewan, and the Saskatchewan Basin ware region of Alberta, is required. A rethinking of these typological entities would be valuable in recognizing what dynamic interrelationships may have occurred between the two regions. Technically based analyses may be the key to such reevaluation.

Preface

It may seem rather unusual that one partially reconstructed ceramic vessel provides much of the basis for a study of the prehistory of an island site in the boreal forest. One might even be justified in making a comparison between such a study and the thoughts of the village fool who, upon extended contemplation of his bellybutton, decided that all the answers to the mysteries of the universe could be found therein. Regardless, a premise of this thesis is that the answers to the most wide-ranging questions about Black Fox Island's prehistoric settlement are to be found in the intensive analysis of Pot 1.

A theme of this study, with implications for the study of prehistoric ceramics in general, is that pottery typologies have relied on comparisons of formal and stylistic attributes, becoming more and more divorced from a realization of the behavior connected to the manufacture of ceramics. In this vein, I can only echo a statement by H.W.M. Hodges in his critique of the "art historian" approach to ceramics analysis in Europe:

> Morphology and decorative detail are the accepted overriding criteria in establishing the relationship between different ceramic traditions: it would even be fair to say that the actual materials and techniques employed by prehistoric man have only seriously been considered in cases where a particular group of pottery is so outrageously different from others in the same archaeological context as to demand some comment. Although the adoption or rejection by prehistoric man of a particular pottery-making technique must have been as much a result of cultural tradition or contact as the adoption or rejection of a particular decorative style, an adequate account of prehistoric ceramic

> technology in Europe remains to be written, while the technical examination of pottery, far from being the routine matter it should be, is seldom even contemplated (Hodges 1965:114).

If transferred to the situation of ceramic analysis in Western Canada, this critique would have much the same content. Taxonomic systems for the various prehistoric pottery yielding regions abound, mainly based on considerations of style and form. Such taxonomic systems are set up for the purpose of giving pottery remains spatial and temporal contexts. These two contexts, once established, are sometimes used to provide an ethnic identification. Admittedly, these are valid and valuable contributions to prehistory. Besides their value for constructing regional chronologies, existing typologies can also provide information on the transmission of ideas on culturally acceptable pottery decoration. However, it should also be of interest to prehistorians to understand how prehistoric potters came to develop their craft and how they practiced it.

The use of 'procedural modes' to characterize ceramics in terms of technique of manufacture was discussed by Rouse (1960). Certain attribute clusters were to indicate common cultural practices, or traditions, of manufacture. The use of modes is intended to surpass the limitations of taxonomic categories (Rouse 1960:320-321). In Western Canada (Manitoba, Saskatchewan, Alberta), the most definitive studies of ceramics have been mainly in terms of types, in attempts to trace the ethnic-historical identities of the

groups who produced and used ceramics (MacNeish 1958; Hlady 1971; Meyer 1978, 1980, 1981); with few overtures to the use of the mode concept (Byrne 1973).

With recognition of the similarity to Rouse's proposal (1960:321), I suggest that, in the Western Canadian "prairie" provinces, taxonomic systems based on characteristics of decoration and form need to be supplemented by concerted inquiries into the transmission of technical practices of pottery manufacture. The way in which the taxonomic systems are set up now provides for identification of prehistoric ceramics mainly in terms of static geographic and culture group entities, with the proverbial line boundaries marking their limits. Detection and identification of the ebb and flow of intergroup relationships is not facilitated by the established typologies. It is possible to distinguish varieties within these type entities, based on differences in form, structure and surface finish; but it is not entirely clear what these varieties might mean in terms of cultural dynamics. An examination of the technical correlates of pottery-making, which can reflect ethnicity or group affiliation as surely as do attributes of decoration and shape, can add to the data to identify interaction between the southern boreal forest of Alberta and other areas.

In this thesis, I will address three distinct questions:

1) Are each of the existing Western Canadian taxonomic

systems for prehistoric pottery adequate? That is, do they a. readily permit the accurate classification of previously unclassified pottery samples; and b. focus on the features most significant in formulating a culture history for a site and in looking at the cultural dynamics of region with ceramics?

2) How would the routine identification and reporting of manufacture technique improve the quality of the data from prehistoric ceramics, and thus improve the quality of interpretations from ceramic assemblages?

3) a. Was Pot 1 made on Black Fox Island? An affirmative answer would indicate an indigenous ceramic industry previously not proposed for the boreal forest of Alberta. Or was Pot 1 more likely made elsewhere and brought to the island?

b. What are the features of Pot 1 which indicate other behavior connected to its manufacture?

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This thesis is dedicated to the memory of those people who once camped, hunted, fished, made stone tools, and used and left their pottery on Black Fox Island.

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I. Chapter One - Introduction

Lac La Biche was chosen as the study area for two main reasons. One, it was known to have a rich archaeological background (McCullough 1975, 1977). Secondly, site GfPa-32, on Black Fox Island in Lac La Biche (Figure 1), was known to have pottery, as reported by McCullough. The excavation of GfPa-32 thus posed an unique opportunity for recovery and analysis of an artifact type which rarely occurs archaeologically in the southern boreal forest of Alberta.

Site GfPa-32 was chosen as the focus of the data collection. It was thought that excavation of the site would reveal information on the physical and cultural contexts of the pottery, and provide samples of the pottery for intensive analysis. Reconnaissance and evaluation of other archaeological resources on the island was stipulated as part of the research contract between the author and the Archaeological Survey of Alberta. Fortunately, testing for other sites on the island was not extraneous to the aims of the thesis project, but contributed information to the interpretation of site GfPa-32. The sum of the data from Black Fox Island (see Appendix 1) contributes to knowledge of the activities of the prehistoric people once there, and to the broader picture of the prehistory of the Lac La Biche region.

A. The aims of the pottery analysis

The emphasis of the Black Fox Island (BFI) analysis was on the pottery sample found at site GfPa-32. While the lithic and faunal collections yielded from GfPa-32 provide data on economic and subsistence patterns (Learn 1982), it was felt that the pottery sample could possibly provide data beyond the most rudimentary economic and subsistence details. The Black Fox Island pottery had the potential to provide data on ethnicity and the transmission of a technical practice, namely, pottery manufacture.

There are several reasons why it was felt that the pottery component of site GfPa-32 could provide data on historic processes. It was possible to identify the pottery according to a recognized stylistic-typological classification, and possibly ethnicity could be inferred from this identification. As demonstrated in Chapter Two, the shape of the pottery vessel and its decorative pattern, plus certain visible technological features, identified the vessel as belonging to the Saskatchewan Basin ware type as defined by Byrne 1973. This identification is in contrast to its initial type designation of Clearwater Lake Punctate style (McCullough 1975, 1977, 1982).

The new type assignment contradicted a previous ethnic identification of Cree, which is usually associated with Selkirk complex ceramics (Syms 1977:108), to which Clearwater Lake Punctate type ceramics belong. Saskatchewan Basin ware is thought to be associated with Blackfoot (Byrne

1973:515-531), and certainly with a Plains group of some sort. Through pottery type and associated culture group identification, the potential to hypothesize certain historical processes was imparted to the investigation. Relevant questions were: how did the pottery arrive on site GfPa-32? what functional or other significance did the pottery have on site GfPa-32? what were the social connections of the GfPa-32 group to other pottery-using and producing groups of the boreal forest and nearby parkland and plains regions?

Part of the research plan was to discover if the pottery vessel could have been manufactured locally, of beach clay from the island. It seemed logical that site habitation and resource utilization could have extended to the manufacture of pottery vessels as needed by the site's inhabitants. Further, a discovery of local manufacture using local clay could imply such things as the presence of women (Hanna 1982:71); a need for and use of pottery; and a specialized activity with associated specialized technological features such as a firing pit, clay storage area and tools used in forming and decorating pottery.

The process of pottery manufacture, as indicated by the physical characteristics of the BFI sample, is also a subject of investigation. A categorization based on the traditional visual inspection of style or form of material culture is not sufficient to elucidate the historical processes which influenced a prehistoric culture.

B. The approaches to the research problems

Although there are some ethnohistoric and archaeological references relevant to the study of the pottery vessel found on site GfPa-32 the main body of data concerning the pottery is the pottery itself. Without a great amount of supportive and circumstantial evidence about the pottery, techniques to derive the maximum information about its occurrence on the site were necessary.

An analogic approach is often implicitly used in the archaeological analysis of material culture. It is based on observations of the results of technological processes enacted in experiments or by ethnographically recorded groups. As presented in this thesis, the analogic approach to a reconstruction of pottery technology is based on the fact that characteristic features result from certain steps in the pottery manufacturing process. When the characteristic features are observed, a corresponding technical process or processes may be inferred.

In this study, pottery-making behavior is considered to be a dynamic interaction between the potter's intent, having ideational and functional components, and the materials of manufacture, to result in a final product, the vessel. In other words, material objects are created by people to conform to a correct perceived stylistic and functional form as best they can with the raw materials available to them. In current archaeological theory, this statement probably is closest to Sackett's (1982) isochrestic approach. A visually

obvious decorative component, punctates and fabric impression, is shared by Late Saskatchewan Basin complex ceramics and Clearwater Lake Punctate ceramics. This surface finish similarity is proposed to be based in the interaction of the potter's construction and decorative tradition with the potter's materials. Cross-culturally shared decorative components may indicate that technical behavior was influenced by cultural dynamics which promoted direct or indirect contact with ideas and technical expertise.

Provenience studies of potential source clays were important to define the circumstances of the vessel's occurrence on Black Fox Island. Instrumental neutron activation analysis was the technique used to detect the chemical-elemental content of suspected source clays and compare their chemical-elemental contents to those of the pottery.

Instrumental neutron activation analysis of pottery and potential source clays may lead to rejection or acceptance of a hypothesis of local pottery manufacture. Either result may indicate a need for further examination of the cultural historical context of the pottery to make the circumstances of the pottery's occurrence on a site clearer.

In the present study, analyses were conducted to see if the clay and the pottery elemental contents coincided, showing that the vessel from GfPa-32 was made of clay found on the east shore of Black Fox Island. This event would have indicated an indigenous pottery industry for the boreal

forest of north central Alberta. The clay and the pottery elemental characteristics did, however, diverge from one another, suggesting manufacture elsewhere and transport of the vessel to the island.

Once the information about source clay provenience and pottery technology was known, it was possible to consider again the archaeological and ethnohistorical literature to identify those culture groups which may have manufactured and/or used pottery in the Lac La Biche region. The extrapolation of culture group affiliations of the inhabitants of GfPa-32, through information related to the pottery, is not guaranteed. However, any new information brings us closer to identifying the people who were in the area. Pottery is one of the most plastic mediums found in the archaeological record, and it is easily molded and decorated as the potter's cultural values dictate. For this reason, it seems that pottery may be a useful vehicle to determine the ethnicity of the site inhabitants.

The GfPa-32 pottery assemblage was one of the northern most occurrences of pottery in Alberta, and certainly the most diagnostic sample in comparison to samples of pottery found at Wappau Lake, 50 miles north of Lac La Biche, and other sherds found in the Lac La Biche area. Perhaps the pottery assemblages of several north-central Alberta sites (Figure 2) have some relationship to one another. If the context for the Black Fox Island pottery assemblage is more firmly established, perhaps this information will lend a

further dimension to other boreal forest sites, particularly if a satisfactory conclusion as to the ethnicity of the site inhabitants and pottery manufacturers is reached.

C. The historical context of boreal forest pottery: The archaeological evidence

Pottery in the Alberta boreal forest

Site GfPa-32 was remarkable in providing a diagnostic and stylistically analyzable Late Prehistoric pottery sample in the boreal forest of northeast Alberta, but it is not unique for the incidence of pottery in that region. Other sites in northeast Alberta have yielded small samples of pottery (Figure 2). During the course of investigations at Calling Lake, Gruhn found "Two tiny potsherds"(Gruhn 1981:65). These "truly minute" specimens were found in the Ah horizon at site GhPh 107, at depths of 9 cm. and an unknown level. They were discerned to be vessel lip fragments, decorated with "a series of incomplete shallow linear impressions." (Ibid.). They are described as each having a flattened lip which formed a right angle with the rim. They are buff color, with a "fine sandy temper"(Ibid.). Unfortunately, this sample provides little more than data on distribution of pottery. The sample sherds are too small in size to be assigned to a pottery type or to know the function of the ceramic object represented. The stratigraphic depth of the sherds does, however, indicate a

Late Prehistoric time period for the pottery.

During an impact assessment at Wappau Lake, Pollock (1977) found pottery at the Narrows Site (GiOv-1). As illustrated in his report, the Wappau Lake sample appears to be undiagnostic (Pollock 1977:Fig. 28:1-6). However, despite the sample condition, he attributes the pottery to the Cree Indians. As the sample condition would have made it impossible to discern diagnostic or stylistic features, his rationale for attributing the pottery to "Algonkian speaking Cree Indians" (Ibid.:53) must have been on the basis that the Cree are known to have produced pottery, of the Selkirk ware type, and they are thought to have been in northern Alberta during the Late Prehistoric period. However, the Wappau Lake sample is not diagnostic enough to place it unequivocably within a pottery tradition or to attribute it to an ethnic group.

Pollock also found pottery at Cold Lake Provincial Park, at site GcOm-7. The body sherds found were not described in his report, but he does mention the sample was the first aboriginal pottery ever reported for Cold Lake (Pollock 1979:60).

Pollock reported yet another incidence of pottery, at the Strathcona Science Park site (FjPi-29). This sample was, in contrast to the ones he found previously, diagnostic enough (that is, complete enough, and with sufficient attributes) to assign it to the Saskatchewan Basin ware type, through consultation with W.J.Byrne (Ives, et al.

1980:39). The Saskatchewan Basin complex, herein referred to as SBC, is best defined for sites in Southern Alberta, where ceramics occur in fairly large quantities. The identification of the Strathcona Science Park sample as Saskatchewan Basin ware goes beyond mere pottery distribution data by indicating a link between sites in southern Alberta and a north-central site.

Pottery assigned to the Late Prehistoric periods was found by R. Balcom near Ft. Saskatchewan. In her report (Balcom 1982:49), there was no description of the pottery, just a report of its incidence and the time period (Late Prehistoric) of which it is thought to be representative. In the Lac La Biche area, there have been surface finds of pottery from sites other than GfPa-32 (T. Maccagno, personal communication). The author had an opportunity to examine several of the pottery sherds from the Lac La Biche surface collections. They appear different in ware type than the sample from GfPa-32.

It is obvious that the Black Fox Island pottery sample is not an isolated instance of ceramics in the north-central Alberta. However, pottery is not an artifact common to Alberta southern boreal forest sites, nor is it found in great quantities when present. This information seems to indicate that the boreal forest of Alberta did not have an indigenous pottery industry. Pottery is rarely found in that geographic location, so it seems not to have been an integral part of the cultural tradition. If not indigenous

to the boreal forest of Alberta, then where did the GfPa-32 pottery originate? The analysis of pottery from this geographic region involves a search for its origin. In this thesis, the search is conducted via a comparison of the BFI sample with pottery of surrounding regions.

Prehistoric pottery found in the Manitoba and Saskatchewan boreal forest regions and the other regions of those provinces, and the ceramics of southern Alberta, have been extensively studied by archaeologists in terms of stylistic and selected technological characteristics, and distribution. The larger number and better condition of the samples from these regions has allowed more thorough analyses of the pottery there while similar analyses have been limited in north and north-central Alberta due to the low quantity and poor condition of the samples derived from this region.

Selkirk ware - The Clearwater Lake Punctate pottery complex

The Black Fox Island pottery sample was initially identified as Clearwater Lake Punctate type (McCullough 1977, 1982). In many respects, Clearwater Lake Punctate pottery is similar to the Black Fox Island sample.

The Clearwater Lake Punctate pottery type, hereafter referred to as CLP, is described as one of three complexes within the Selkirk ware designation (Hlady 1971). Selkirk ware was defined by MacNeish who first termed the ceramics from southeast Manitoba Winnipeg fabric-impressed ware

(MacNeish 1958:162-6). Winnipeg Fabric-impressed ware ceramics have been impressed with a woven fabric on the exterior surface. It is not known if this trait is decorative, or functional, or both. Sometimes the impression was smoothed, partially obliterating the fabric impression. Another distinctive trait is the seemingly decorative punctates or linear impressions sometimes occurring on the lip or rim. Sometimes there are no impressions on the neck or rim. Selkirk focus ceramics are thought to have been made from ca. A.D. 1200 through the Late Prehistoric period, and possibly through to the fur trade period in Saskatchewan (Meyer 1981:26).

As a regional complex within the Selkirk ware horizon (Syms 1977:107), Clearwater Lake Punctate (CLP) possesses the general attributes of Selkirk ware, with specific variations. Clearwater Lake Punctate was identified through samples obtained at the type site, the Clearwater Lake site, excavated by W. Hlady from 1954 to 1960, and by examination of the collections belonging to amateur archaeologists (Hlady 1971:5,7). Hlady describes Clearwater Lake Punctate pottery on the basis of paste, method of manufacture; surface finish; vessel form, including body, base and neck shape, manner of lip and rim formation, rim decoration; and what was then known of its geographical range and probable temporal range (Ibid.:7-8).

Clearwater Lake Punctate pottery is described as having "Fine to medium sand or grit and medium to coarse crushed

granite." as the tempering material; with a "medium to coarse" texture; "poor" paste consistency; black to light brown in color; and hardness of 2.0 to 3.0, which is somewhat friable (Ibid.:7). Hlady judged the method of manufacture to be paddle and anvil, noting that it was definitely not coiled. The surface finish of the samples corresponds to MacNeish's definition of three variations of fabric impression for Selkirk ware. The lips were fabric-impressed, then smoothed and flattened. Rims were fabric-impressed. All rims had a row of circular punctates on the exterior surface, with resultant bosses on the interior. Punctates were approximately 1.6 mm - 7 mm in diameter. Neck and shoulder variations were a) a neck with a sharp curve to form a large shoulder angle and b) a more gently curved neck with less pronounced shoulder. The typical base is defined as rounded, with an occasional flattened base (Ibid.:8). This description provides the basis for assigning a pottery rim or vessel fragment to CLP type.

Distributions of Clearwater Lake Punctate ceramics in Manitoba and Saskatchewan

Syms (1977:107-108) discusses the geographic range and the ethnic association of the Selkirk CLP pottery horizon. He summarizes the geographic range: "The Clearwater Lake Complex,... is a northern regional expression of the Selkirk Horizon. It is confined to an area of Northern Manitoba,

Saskatchewan, and possibly adjacent Ontario... Known sites are confined primarily to the Saskatchewan and Churchill River systems." Selkirk materials are attributed to Cree by MacNeish 1958; Hlady 1970, 1971; Mayer-Oakes 1970; J.V. Wright 1971; and D. Meyer 1974 (Ibid.). The association cannot be based on ethnohistoric accounts of Cree ceramic technology, but it is based upon the correspondence of site distribution with a known distribution of the Cree during the early historic period. See Figure 2 for a representation of CLP range in Saskatchewan and Manitoba.

The temporal range of the Clearwater Lake Punctate (CLP) phase in northern Manitoba and Saskatchewan is stated as ca. A.D. 1400-1775 (Meyer 1983:45). The lithic assemblage associated with the Clearwater Lake Punctate phase includes Prairie side-notched, Plains side-notched, Eastern Triangular, Selkirk side-notched, and Whiteshell side-notched projectile point types (Hlady 1970:114; 1971:22-23).

Minni (1976) identified CLP at Black Lake in northern Saskatchewan, approximately 40 miles east of Lake Athabasca. Forsman, 1976, identified it for Montreal Lake in northern Saskatchewan (Meyer 1978:7). Meyer (1978) analyzed the Selkirk ceramics of the Late Woodland Saskatchewan cultures from site collections of a large area of the boreal forest region of east central Saskatchewan. He looked at pottery of the Clearwater Lake Punctate type with reference to Hlady's definition (Meyer 1978:7-9), and its geographic distribution

in Saskatchewan at a number of sites in the Churchill River system and the Sturgeon-Weir River system (Ibid.:9-28). Clearwater Lake Punctate type was also attributed to the Nipawin area of the Saskatchewan River valley by Meyer (Meyer 1981:24-25). Meyer at first felt that the Nipawin area ceramic complex differed somewhat from Hlady's definition of CLP although the diagnostic fabric impression and punctates are present. He initially assigned the Pehonan complex to Selkirk Winnipeg Fabric-impressed ware but changed his evaluation, saying Pehonan, in his opinion, "must stand alone as a fringe phenomenon."(Meyer 1981:31).

In the distribution of Pehonan type versus Clearwater Lake Punctate type, Meyer sees a "distinct break" between the Nipawin area pottery (Pehonan) and the more northerly (Montreal L. or Sturgeon-Weir R.) CLP sites(1980:13). This observation was also made by Byrne, in a comment which appears to refer to Meyer's then undefined Pehonan complex. Byrne noted that "clearly recognizable Selkirk pottery," that is, not merely pottery with the attribute of fabric impression, but with the full range of Selkirk attributes, "appear to concentrate in the northern and eastern sections.", that is, north of the North Saskatchewan River (Byrne 1973:406). This pottery seemed to be a combination of Selkirk and local pottery attributes, with some influence perhaps from southern Alberta and other parts of Saskatchewan, according to Byrne (Ibid.).

Meyer hypothesizes that the Pehonan complex distribution may correspond to the parkland/forest transition zone to the west of Nipawin, but the geographic range is not actually known from archaeological investigation (Meyer 1980:13). Meyer sees the Pehonan ceramic style as intermediate between the pottery of the Saskatchewan and Alberta grasslands and the pottery of the boreal forest Clearwater Lake phase (Ibid.:15). He proposes that the people were Algonkians, possibly proto-Cree, who may have had a seasonal round within the parkland/forest transition zone, utilizing resources of both regions (Ibid.:16). Pehonan style pottery is said to be a variant of Clearwater Lake Punctate, suggesting variation within an ethnic group corresponding to the pottery type variation.

The author suggests that if a Pehonan variant of CLP type is recognized, in the future archaeologists will recognize various other regional variants of CLP. Generally speaking, variations of a pottery type would seem to be unavoidable as the group(s) which produced it advanced to new territories, taking with them their pottery template, and changing it as they came into contact with other groups and became isolated from the 'mother' group.

The Saskatchewan Basin complex --

The Saskatchewan Basin complex was first defined by W.J. Byrne, who established two ceramic complexes for southern Alberta. During the course of his study, he

identified the Cluny complex, assigned to the Protohistoric period, and the Saskatchewan Basin complex, divided into early and late variants assigned to the early Late Prehistoric and the late Late Prehistoric/Protohistoric periods respectively (Byrne 1973:i).

Byrne's objective was to analyze the ceramics associated with the prehistory of southern Alberta to augment and refine the chronological order based on lithics analysis, and to better understand the cultural dynamics of the region. For the purposes of the Black Fox Island study, the observations related to pottery attribute comparisons on a geographic/spatial basis are more valuable than the diachronic relationships referred to via the pottery attribute analysis.

According to Byrne, his Saskatchewan Basin ware has affiliations with southern Saskatchewan and Manitoba ceramics; whereas Cluny is thought to be ultimately derived from Middle Missouri ceramic traditions (Ibid.). The ceramic complexes are associated with the lithics of the phases recognized in southern Alberta. The early variant of Saskatchewan Basin ware is associated with the Avonlea phase, and the late variant with the Old Women's phase (Ibid.). The early variant is associated with Period I at the Morkin site, A.D. 150/250 - A.D. 1150. The late variant is dated at ca. A.D. 1150 - A.D. 1700, which is Period II at the Morkin site (Byrne 1973:341, 364-5).

To attain his goal of looking at the dynamic interrelationships of cultural units via the ceramic complexes throughout the northwest plains, Byrne formulated and identified the cultural entities in terms of pottery entities and seriated them to arrive at a chronology. He then looked at what changes characterized each cultural unit, and attempted to explain the dynamics of the change. This approach reflects his belief that, because clay is a plastic medium, it can easily reflect "even the subtlest influences of culture contact or chronological change (Byrne 1973:v).

Byrne chose attribute-mode analysis over type analysis. He vetoed the type approach because a type is a closed system, which presents difficulty when modifications to the old system are needed. The attribute analysis approach has the potential to be more consistent, due to its flexibility for additions or changes to incorporate new information. Each mode,"a pattern of attributes that distinguishes a group of artifact features, such as rim profiles and defines it as a class" (Byrne 1973:325, after Rouse 1972), could be used for comparison with other modes to arrive at conclusions related to culture history and dynamics. Byrne decided that his ceramic groupings were close to the "pottery tradition" concept of Willey where "a line or a number of lines of pottery development through time [are] within the confines of a certain technique or decorative constant." (Ibid., after Willey 1945:53). However, Byrne

decided to use "complex" rather than "tradition" to designate his mode/attribute clusters (Ibid.:237).

In Byrne's study, the pottery samples from the Morkin site (DlPk-2) and other sites in southern Alberta were extensively analyzed and classified. The Morkin site is approximately 50 miles northeast of Lethbridge, Alberta (see map, Byrne 1973:666). The classification system involved first placing each sherd within a "major ceramic class" designation which takes into consideration the paste (texture, temper, color, hardness) and the surface finish of the sherd (Byrne 1973:29-30). Next, each sherd was further categorized according to the section of the pottery vessel from which it was derived. Finally, each sherd was assigned to a "Variant" subclass (Ibid.:31-2) which takes into account distinguishing attributes and allows a refinement of the major ceramic class and vessel section classification.

For the early variant of Saskatchewan Basin ware, which is antecedent to the late variant, Byrne suggests a "generalized correspondence in paste, vessel form and decoration" with Laurel ware of Manitoba (Byrne 1973:457). The surface finish of the two wares also corresponds to some extent (Ibid.). Byrne is not necessarily implying that the origin of the southern Alberta pottery tradition was dependent upon the Laurel complex, which is a fairly early complex also manifest in Northern Ontario. There may have been "some kind of contact with the people making Laurel ceramics in Manitoba" (Ibid.), a contact resulting in trait

infusion. This is the earliest and most easterly influence that Byrne proposes for the Southern Alberta pottery complex.

Byrne decided to restrict his examination of pottery connections between southern Alberta and other regions by looking at areas only to the immediate east and south of Alberta (see Byrne 1973:371-373 for rationale). He cites similarities between the early variant ceramics of the Saskatchewan Basin complex and certain ceramics from sites in Saskatchewan and Manitoba including the Avery site (Ibid.:376-380). From this information, he constructs a hypothetical scenario whereby the early variant ware developed in southeastern or central Saskatchewan, and spread eastward to Manitoba, and at the same time moved westward into Alberta, all around A.D. 500 (Ibid.:385).

Byrne finds some correspondence of the attributes of the late variant ceramics of Saskatchewan Basin ware with attributes of pottery from Ethridge, Montana. The Ethridge ware has a coarse paste with moderate amounts of crushed granite and temper, a grey to dark grey core and interior, and a hardness of 3.0 to 4.5 on the Mohs scale, plus other similarities to some classes of late variant Saskatchewan Basin ware (Ibid.:386). Byrne considers that the relationship of the late variant ceramics of the Saskatchewan Basin complex to pottery from regions to the south of Alberta was generally not strong. However, Ethridge ware is seen to be one of the closest (Ibid.:393). Ethridge

ware was defined by A. Kehoe (1959). Kehoe claims that the range of Ethridge ware extends to the North Saskatchewan R. in Alberta, to Edmonton; and the southern extension is to north-central Montana, and east to the Alberta-Saskatchewan border.

Ethridge pottery was ovoid or globular in shape, with rounded bottoms; and often had carinate (angular) shoulders, constricted neck and flattened rims (Kehoe 1959:240). Exterior finish consisted of cord-wrapped paddle impressions, fabric-impressed ("a heavy twined or wrapped fabric"), or smooth surface. The author suspects that Kehoe's Ethridge ware could be assigned to a class within Byrne's Saskatchewan Basin ware.

Because of the lack of similarity with pottery from the south, Byrne concluded he must look to the east, to Saskatchewan. He examined ceramics from the Walter Felt site and the Mortlach site and found them similar to the late variant Saskatchewan Basin ware (Ibid.:393-4). Byrne consulted the descriptions of pottery from the Long Creek site and found it corresponded to the late variant ware in its coarse, grit-tempered paste and vertical cord-marking or fabric impression. Byrne's further comparison of the late variant of Saskatchewan Basin ware with Saskatchewan ceramics includes an examination of the attributes of a fabric-impressed vessel from the Nipawin area. The vessel was in association with historic goods at the Francois LeBlanc post (HBC), in operation from 1768 to 1773 A.D. This

partially reconstructed vessel resembles Class M of late variant Saskatchewan Basin ware (Byrne 1973:397).

Byrne groups pottery from various surface collections throughout Saskatchewan with pottery from Reindeer Lake, found by Downes in 1938, and pottery from a locale east of Lake Athabasca reported by Wright in a personal communication to Byrne (Ibid.:398). Byrne is here undoubtedly referring to Minni's discovery of what she termed Clearwater Lake Punctate pottery at Black Lake, Sask. Byrne states here a crucial observation in comparing the late variant Saskatchewan Basin ware with Saskatchewan pottery. "The main difference between the pottery of the two provinces is that the Saskatchewan pottery tends to be thinner." (Byrne 1973:399, emphasis mine). This particular observation is of immediate use in differentiating between the ceramics of Alberta and Saskatchewan; and as will be seen later, between Saskatchewan Basin ware and CLP.

Byrne also notes that, on CLP pottery, the "internal bosses are raised more often" (Ibid.). It does seem to be the case that when the thinner walls of CLP were punctated, an obvious bulge would result, in contrast to the SBW which had thicker walls to sink the punctates in, thus forming less prominant bosses on the wall interior.

Another difference between Clearwater Lake Punctate and late variant Saskatchewan Basin ware is the trait of angular shoulders for the late variant SBW but not for CLP. Referring to the characteristics of his Pehonan ware, Meyer

notes that "Angular shoulders and shoulder decoration are traits characteristic of the late prehistoric (non Middle Missouri) pottery of the Saskatchewan grasslands." (Meyer 1981:30). He says that the trait of angular shoulders also separates Pehonan ware from CLP. The importance of these two distinguishing traits of shoulder angle and wall thickness will be further discussed when comparing the Black Fox Island pottery sample with CLP and late variant SBW.

From the comparisons noted above, Byrne has arrived at a hypothetical relationship of Saskatchewan Basin ware with areas to the east and south of southern Alberta, which he decided were the most likely areas of relationship (see Byrne 1973:372-3). He sees the pottery from Saskatchewan as, in a sense, transitional between southern Alberta and Manitoba ceramics, specifically, "typologically as well as geographically transitional between Manitoba Corded and Winnipeg Fabric-impressed on the one hand, and the late variant of the Saskatchewan Basin complex on the other."(Ibid.:405). The concept of the Saskatchewan pottery as "transitional" in those respects underlies a certain separation between the Manitoba and southern Alberta ceramics, for "[the] Saskatchewan pottery exhibits greater similarity both to the late variant ceramics of southern Alberta and to the Manitoba corded and Winnipeg Fabric Impressed complexes of Manitoba than the Manitoba and Alberta sherds do to each other." (Byrne 1973:407). This separation does not in any sense, however, detract from the

role which Byrne sees for the Selkirk ware as the ultimate source of certain stylistic and, probably, technological attributes manifest in the southern Alberta Saskatchewan Basin complex (Ibid.:437).

II. Chapter Two - Visual Methods of Pottery Analyses

A. Part One: Taxonomic Assignment of the GfPa-32 Vessel

Pottery is a potentially valuable artifact for cultural interpretation. If pottery can be assigned to a type, it will aid in establishing a chronology and archaeological culture affiliation for the site and the island.

A pottery sample previously found at site GfPa-32 was assigned to the Clearwater Lake Punctate type (McCullough 1975, 1977, 1982). The pottery sample found at GfPa-32 in the summer of 1982 is probably from the same vessel as that reported by McCullough. This equation was made through reference to a photograph of the 1975 sample and consultation with E.J. McCullough who agrees that the sample he obtained is visually similar to that obtained by the author. The sample collected by McCullough was not available for actual examination.

The assignment of the GfPa-32 vessel, hereafter referred to as Pot 1, to CLP was in doubt after the author compared the Pot 1 sherds with other pottery, from Saskatchewan, assigned to the Clearwater Lake Punctate type. The Pot 1 traits were also compared to the attributes described for classic Clearwater Lake Punctate type (Hlady 1971). The most obvious similarities to CLP for the Pot 1 vessel were the decorative characteristics of the punctates and the impressed surface.

The author agrees there are some key attributes common to the Clearwater Lake Punctate type, as defined by Hlady (1971), and Pot 1. The rimsherds of the GfPa-32 sample have the roughly textured exterior surface finish which could be called "fabric/net impressed" as in Clearwater Lake Punctate type, and an interior smooth finish. The single row of punctates on the neck also corresponds to the decorative motif associated with the type. These attributes are the most obvious correlates to the Clearwater Lake punctate type definition.

General description of Pot 1

The attributes of the GfPa-32 pottery, hereafter referred to as Pot 1, which are generally considered most useful for immediate visual diagnostic purposes are decoration, surface finish, paste (including texture and temper) shape and form of the various structural elements of the vessel, and coloration of the sherds. These are the attributes which help determine type assignment. They are discerned using the unaided eye, magnification, and plasticene impressions.

The description of Pot 1 will parallel the descriptive information of Hlady (1971) for Clearwater Lake Punctate pottery and Byrne (1973) for Saskatchewan Basin Ware. Both Byrne and Hlady include data on the inferred methods of manufacture in their descriptive sections, incorporating some technical interpretation with the description of marks

or other features of the sherds. In a later section, the author will focus on the interpretation of construction technique. See Plate 1 for the reconstructed rim of Pot 1.

The paste

On a smoothed interior surface the paste appears fairly dense, of medium to low porosity. The same conclusions about the paste are drawn from observation of cross-sections and of exfoliated pieces. At a sherd edge or exfoliated surface, the clay is uneven rather than smooth. The paste appears silty in texture, and well-compacted. The temper may have been both naturally and artificially-introduced into the raw clay. The natural inclusions in Pot 1 are most likely sand and organic particles. The culturally-introduced inclusions are likely the large (up to 8.0 mm in length) granitic particles; and the medium to small granitic, mica and quartz particles; and some sand particles, all of which can be identified through non-microscopic examination. The large pieces of granitic grit are angular, fragmented probably along natural fracture lines. They appear to be well-incorporated and adherent within the paste. Some of the Pot 1 grit particles are unusually large. It is presumed that the large particles provide an optimal tempering medium for the particular vessel. Grains of sand and the smallest particles of quartzite constitute the majority of the tempering material.

Surface finish and punctates

The external surface finish is characterized by short line segments impressed into the vessel surface, resulting in an overall pattern of ridges and indentations running parallel to one another. The design or impression is continuous and unpatterned. This surface finish is often referred to in the literature as fabric-impressed design. It has been speculated that this surface finish results from application of a piece of woven fabric or fishing net to the outside of the vessel.

The interior surface of Pot 1 was smoothed, resulting in a flat, non-porous surface. Occasionally, striations and varied marks appear on this smooth surface. The marks appear to have been made unintentionally as there is no discernable pattern. Grit particles occasionally appear on both the interior and exterior surfaces, and it appears that no particular attempt was made to remove them from the surfaces.

Round punctates are "punched" into the neck sections at an interval of 22.0 - 30.0 mm from one another, and approximately 15.0 - 22.0 mm from the external lip edge and 22.0 mm from the shoulder ridge crest. The punctates have smooth walls, and all are fairly uniform in shape. In most cases, the punctate does not go completely through the vessel wall, although exceptions occur. In these exceptions, the emergence of the punctate through to the interior wall appears to have been intentional.

A series of short, diagonally-oriented lines are impressed at irregular intervals on the interior of the rim adjacent to the lip. The sizes of the impressions vary, but on average are 1.0 cm in length.

Form and structure

Currently, Pot 1 has been reconstructed from the lip to below the shoulder in some spots. The vessel shape is therefore not completely known. However, a description of several structural features may be made.

The lip of the rim is flattened or level. There is a discontinuous ridge at the point where the lip meets the exterior of the neck. This feature may be called a thickened lip. At some points, the lip edge meets the neck in a uniform thickness, with no ridge present. The neck's walls are slightly thinner than at any other part of the vessel. The neck is slightly concave as it slopes from the lip edge ridge to the apex of the shoulder. The shoulder, where the neck meets the body, is sharply angular in cross-section, and the walls at the shoulder are thickened.

The body sherds appear to be of a fairly uniform thickness, about 10.0 mm. Several of the body sherds are split laminarly, into two almost equally thick portions. No basal sherds have been recognized in the sample, but curved bodysherds indicate a rounded or globular shape for the vessel.

Color and surface incrustation

The majority of Pot 1 is of a dark to medium grey-brown color. Occasionally, an entire sherd or part of a sherd is tan or orangish in color.

A carbon-like incrustation was present on the interior of a rim sherd of Pot 1. The specific identity of the material causing the incrustation is unknown. The incrustation is black, very brittle and cracked. This carbon incrustation leads the author to think that the vessel was used for cooking purposes.

Thermoluminescence date

A single thermoluminescence date was obtained for Pot 1. The results from Alpha Analytic, Inc. Laboratories place Pot 1 at ca. A.D. 1520. The date reported was 430 B.P.±20% (M. Tamers, 1983, personal communication, Alpha-561).

Definition and description of Clearwater Lake Punctate type

Clearwater Lake Punctate type pottery is defined by Hlady (1971) using rimsherd and bodysherd samples from the Clearwater Lake site in northern (Woodland) Manitoba. Hlady compares the Clearwater Lake Punctate type pottery with MacNeish's 1958 description of Winnipeg Fabric-impressed ware, and states that CLP pottery is a type within Winnipeg Fabric-impressed ware, although there is some variation (Ibid.:16-17). Hlady describes the surface finish of CLP type vessels as impressed by either a cord-wrapped paddle or

fabric-covered paddle. The CLP type is described on the basis of paste, inferred method of manufacture, surface finish, and vessel form. The CLP surface impression is "identical" with that found on Winnipeg Fabric-impressed ware (Ibid.:7,17). The method of manufacture inferred is "probably paddle and anvil" (Ibid.:16). This inference is based on MacNeish's analysis of the method of manufacture of Winnipeg Fabric-impressed ware (MacNeish 1958:163).

Punctates and surface finish

A basic decorative mode and twenty-one additional modes of decorative treatment are described for rimsherds of the type (Hlady 1971:8-16). The basic rimsherd mode is defined as fabric-covered paddle impressed, with a smoothed or truncated lip surface finish and a row of circular punctates on the exterior rim . The row of punctates is an identifying feature for the CLP type. The typical CLP rimsherd has "a line of circular punctates on the exterior rim with slight to pronounced interior bosses resulting from the punctates. Punctates...vary from 1.6 to 7 mm. in diameter."(Hlady 1971:7). Meyer (1978:8) states that round or oblong punctates are "the norm" in decoration for the Clearwater Lake Punctate pottery. The surface finish is said to have been obtained when a fabric-wrapped paddle or piece of fabric was applied to the vessel exterior (Ibid.:7, after MacNeish 1958).

Paste and vessel form

Clearwater Lake Punctate type paste is described as medium to coarse with a "poor" consistency. The temper is fine to medium sand/grit and medium to coarse crushed granite particles. The paste is said to be particularly friable at the shoulder. The color is black to light brown.

The CLP lip is described as "slightly flattened to flattened" (Hlady 1971:7). The CLP type is described as having two neck variations: "sharply curving...(about 55° to the shoulder)," and "a gently curved neck (about 25° to a less pronounced shoulder)" (Ibid.:8). The base of the typical vessel is described as rounded, but some may be flattened. Clearwater Lake Punctate sherds range from 4.0 to 11.0 mm in thickness, and some sherds may be up to 15.0 mm in thickness.

Comparison of Pot 1 to CLP type description

Surface finish and punctates

As stated, the surface finish of Pot 1 could be described as fabric-impressed. The punctates present on the Pot 1 rim are a motif familiar to the CLP type. The punctates present on the Pot 1 rimsherds are round, falling within the punctate shape variation described by Hlady (1971:8-14). In terms of surface finish and punctate motif, Pot 1 is similar to CLP type.

Paste and vessel form

The paste of CLP is described as generally more friable than the paste of Pot 1, which is well consolidated.

The curvature of the Pot 1 neck from the exterior lip edge to the shoulder is approximately 65° and so is more sharply curving than the typical CLP range. This sharp curvature results in a very pronounced shoulder with a moderately pointed apex.

Vessel wall thicknesses for Pot 1 (rim, shoulder, body) are generally thicker than for CLP type. The average wall thickness of Pot 1 is ca. 10 mm, having a range of 9 - 15 mm, and a normal average (based on a range of 4.0 - 11.0 mm) for CLP is 7.5 mm. For an abbreviated comparison of Pot 1 and CLP, see Figures 3 and 4.

Remarks

Pot 1 could be said to differ from CLP type description with respect to vessel form characteristics. With respect to what is sometimes called decoration; i.e., surface finish and punctates, Pot 1 and CLP are similar. While the decorative similarities may indicate an historical connection between Pot 1 and CLP type, the differences of form indicate the two were formed using at least slightly different technical approaches. Whether the differences in technical approach were in primary or secondary forming techniques will be explored later in this chapter. The author concludes that Pot 1 should not be placed in the CLP

type category as currently defined because variation between the two is too great.

The Black Fox Island pottery and the Saskatchewan Basin complex

The Clearwater Lake Punctate type was not a satisfactory category for the Black Fox Island (Pot 1) ceramic sample. Could Pot 1 be assigned to another, already established type having associated chronological and archaeological cultural information? Or would the Black Fox Island vessel have to be identified as a new type?

At this point, the Saskatchewan Basin complex was a potential category for Pot 1. The geographic and cultural contexts of this pottery classificatory group were discussed in Chapter One, and thus the rationale for comparing the Black Fox Island ceramics with it should be familiar to the reader. A preliminary examination of Byrne's definition of Saskatchewan Basin ware (SBW) from southern Alberta (Byrne 1973) indicated that the Black Fox Island pottery had attributes in common with that type. It seemed appropriate to compare the GfPa-32 vessel, referred to as Pot 1, to the attributes defined for SBW to ascertain if the Black Fox Island pottery could be assigned to the southern Alberta pottery complex.

Byrne's working units for defining attributes within the Saskatchewan Basin ware complex are class and subclass. The attributes described within class are paste and surface

finish. Paste is described on the basis of texture, temper, color, and hardness. Surface finish is described according to physical appearance and technological procedure. Subclass is defined according to the vessel section of the sample. Depending on the particular sherd, it might be further defined with respect to unique characteristics of shape, decoration, surface, or paste of the vessel section. Here the Black Fox Island pottery is compared to the Saskatchewan Basin Ware definition with reference to the class and subclass descriptive format.

In addition to plasticene impressions, Byrne used a hand lens and a 120X to 1000X microscope for observation and description of the surfaces. He used a 10X hand lens to describe the temper for the complex description. Temper was more thoroughly examined during petrographic analysis, as reported in Appendix A (Bower 1973b) and by Bower 1973a. A similar methodology for comparison of the BFI pottery with the SBW complex description was used by the author. A 2X hand lens and a 6.3X to 40X microscope, and plasticene impressions were used to examine surface impressions to compare to the SBW complex description. The 2X hand lens was used to examine surface-visible temper.

The attributes assigned to vessels/sherds of the Saskatchewan Basin complex are listed in Byrne (1973:331-335). To summarize: The paste varies from compact to blocky (see Byrne 1973:30 for texture definitions), and can generally be termed 'coarse.' Temper ranges from minute

to large (maximum ca. 15.0 mm. diameter) with the majority in the middle range; and is mainly crushed granite. Color is black to medium grey-black, and can range to medium grey or tan. The interior surface is smooth. The exterior has been cord-or-fabric/net-impressed. The impression usually has been obliterated, or truncated. Reconstructed vessel form indicates a rounded or flat base and globular body with a tendency to elongation. Wall thickness is ca. 6.0 to 15.0 mm.

Shoulders are ridged and usually thickened in comparison to the other parts of the vessel. Necks are usually short. Rims are usually insloping in profile (Ibid.:334). The lips are usually flat, and thickened. Most vessels have no decoration, except where punctation occurs. Some punctates are circular with a "central cone" or raised area inside the punctate showing use of, possibly, a hollow tube implement (Ibid.). Other decoration may appear.

The above description shows the usefulness of the attribute-mode approach for Byrne's pottery classification task. The sherds obviously share many similarities which qualify them to be within the Saskatchewan Basin complex, yet there are attributes which further define each pottery mode/class and allowance is made for them through the attribute-mode approach to classification.

Class and subclass comparison

The author will use the written description of the SBW pottery attributes to compare Pot 1 sherds to SBW. Plates and figures of some of the pottery assigned to Byrne's classes or subclasses are found in his Appendix (Volume 3). They were used to supplement the descriptive text, especially where a term of reference is unclear. Based on his descriptions, several of these classes appear similar to the BFI pottery. (Refer to Figure 6 and Plate 2).

The Saskatchewan Basin complex classes used for Pot 1 comparison

In initially categorizing the ceramic samples from the Morkin site and other sites in southern Alberta, Byrne sorted them by class, based on paste and surface finish. The author looked at the paste and surface finish of Pot 1 for comparison with Byrne's classes. In Byrne's scheme, subclass further entrenches a vessel within a particular class. The author continued to follow Byrne's pattern of classification by first defining vessel section, and then any significant characteristics specific to the section. Byrne used vessel section categories defined by MacNeish, 1958 (Byrne 1973:674, Figure 10).

The cord-marked class

The cord-marked class (Class A) is described as having an exterior sherd surface which looks as though it was impressed with a cord-wrapped paddle. (See Plates 2a. and

2e.). The most significant traits for describing the visual appearance of a sherd with cord-wrapped paddle impressions are the "pronounced linear impressions which run parallel all over the sherds."; the presence of grooves of certain size and spacing; and marks said to be indicative of twisted cordage (Byrne 1973:33). The cordage marks were left unmodified. Surface finish traits equivalent to those used by Byrne to describe the cord-marked class are observed on Pot 1 sherds. Although Byrne's description for cord-marked surface appears similar to that for the Pot 1 surface finish, the author does not think that the Pot 1 surface finish was caused by a cord-wrapped stick paddling the clay.

In continued comparison of the Pot 1 sample with the description for the cord-marked class, the paste of Class A ceramics is described as primarily compact with occasional blockiness or central laminations (Ibid.:32). The paste of Pot 1 is blocky rather than compact, and it is well consolidated. Laminations are a prominent feature in the Pot 1 sherds. Surface coloration of Pot 1 is not as contrastive from exterior to interior surface as described for the cord-marked class. However, coloration data may not be all that significant (Syms and Corenblum 1977:20).

Subclass

Vessel section subclass comparison shows further similarity between Pot 1 and the cord-marked class. Shoulder section subclass As1 (Figure 6a) is described as angular or

ridged; and without much thickening of the section in relation to the rest of the vessel body (Byrne 1973:34). Pot 1 has an angular or ridged shoulder which is at least five millimeters thicker than the adjacent body. Shoulder subclass As1 has a decorative component which the Pot 1 shoulder section does not have.

The neck section of Pot 1 is similar to the description of neck section subclass An1 for the cord-marked class (Figure 6b). The descriptive accounts of rim subclasses Ar1 and Ar8 seem similar to the Pot 1 rim description, but illustrations from Byrne 1973:708, Plate 6b (Plate 2a, this paper); and 675, figures 11m and 11f (Figures 6c and d, this paper) indicate that they differ from the Pot 1 rim section. An illustration of rim subclass Ar25 (Byrne 1973:709 Plate 7) looks very similar to Pot 1, except that the surface finish appears slightly different and there are exterior lip impressions in addition to exterior punctates (see Plate 2e, this paper).

Discussion

The author feels that there may be some significantly similar traits between Pot 1 and the SBW cord-marked class as described by Byrne (1973). However, a problem arises in assigning Pot 1 to Class A, because it has been determined that the surface finish of Pot 1 is fabric impressed. Cord-marked indicates the act of stamping the surface with a cord-wrapped paddle. Usually impression with a cord-wrapped

paddle results in a discontinuous, or interrupted and overlapping series of impressions. Pot 1's surface finish is a continuous series of cordage impressions.

Fabric/Net - Impressed Class

A second potential class designation for Pot 1 is the fabric/net-impressed class (Class C). Byrne describes the exterior sherd surface of this class as "dimpled"(Ibid.49). The dimpled surface has small, oblong depressions densely packed together and often seeming to overlap. The name fabric/net-impressed is derived from the inferred mechanism of impression, using a net or other loosely woven fabric of coarse cordage. The description of this surface finish seems to parallel the Pot 1 surface finish; but the plate provided in Byrne (1973:704, Plate 2a; and Plate 2b, this paper) does not show a surface finish of obvious similarity to Pot 1.

The paste of Class C is described as "generally blocky but well bonded," having occasional laminations (Byrne 1973:49). The temper is angular granitic grit, moderate in quantity; and ranges to relatively large in size.

Body sherd subclass

Byrne's description of the general body sherd subclass, Cb1, (Ibid.:50) states that sherd thickness ranges between eight and 12.0 mm, with an average of 10.0 mm. Some sherds are slightly curved. These two characteristics are true of the Pot 1 bodysherds.

Rim sherd subclass

The rim sherd description for Class C which most closely approximates a description for the Pot 1 rim sherds is that for subclass Cr3 (Byrne 1973:148, and see Figure 6e this paper). The description mentions thickening of the exterior lip, and a lip surface finish identical to the overall vessel surface finish.

Shoulder subclass

For Class C, no mention is made of a shoulder subclass.

Decorated subclass

Sherds decorated with punctates are mentioned within Class C (Byrne 1973:50-51). A single row of round punctates spaced 5.0 to 8.0 mm apart, and ca. 5.0 mm in diameter, is found on the sherds. The Pot 1 punctates differ in spacing (further apart) and size (larger), but their presence is a shared stylistic trait.

Discussion

The description of the surface finish of Class C (Byrne 1973:49) seems appropriate to describe Pot 1's surface finish, except where truncation is indicated. However, Class C is assigned to the early variant of SBW, so the class is not an appropriate category for Pot 1 based on relative and absolute dating indicators.

Basket/Mat - impressed Class

Assignment to Class L was considered for Pot 1 based on an examination of the Pot 1 surface finish, as demonstrated by the sherds and plasticene impressions. The use of plasticene casts of the surface finish of ceramics is recommended by Saylor (1978). The author consulted a technician at University of Alberta Textile Services, and she suggested that the surface finish of Pot 1 may have been caused by impression with a basket tightly woven using a twined weaving technique; and that the elements used were more tightly woven and more rigid than a net would be (D. Rockcliffe, personal communication).

The exterior surface finish of this class, known as Class L, consists of a "regular series of parallel, shallow troughs,...interrupted by narrow impressions running perpendicularly across them." (Ibid.:82). Byrne describes how this surface impression corresponds to the impression which would be caused by the clay in contact with a coiled basket or matting (Ibid.:83).

The paste is described as very compact with some fine laminations. Temper is low in quantity, and consists of angular feldspar pieces ranging to 4.0 mm. The color is tan grey to orangish tan grey. The interior surface is smooth with some striations. Wall thickness ranges from 3.0 to 12.0 mm.

Body sherd subclass

One body sherd subclass, Lb1, is defined for Class L. Vessel reconstruction indicates a globular shape.

Discussion

On the basis of the comparison with Class L written description and on observation of plate of a sherd assigned to Class L (Byrne 1973:704, Plate 2f, and see Plate 2c, this paper) Pot 1 cannot be assigned to Class L.

Woven-fabric impressed class

Byrne (1973:186) describes the sherds of class M as having a "dimpled" exterior surface with small, elongated pits aligned in a regular pattern (linear). Sometimes the individual pits are not discernable due to overlapping. Byrne proposes that the impressions were made by a coarse twined or plaited fabric of flexible, rigid or semi-rigid elements applied to the wet clay.

Body subclass

Pot 1 is most similar to body subclass Mb2 as described by Byrne (1973:188) and as evidenced by Plate 2e (Ibid.:704; and see Plate 2d this paper). The description and photograph refer to a surface finish produced by a tightly woven fabric of two-ply cordage elements. The surface finish consists of rows of oval depressions, some depressions having linear marks or twist marks indicative of a two-ply cord.

Shoulder subclass

One shoulder subclass (Ms1) is described for Class M. The shoulder ridge is described as "well-developed", and ca. 3.0 mm thicker than the adjacent body of 7.0 mm. This description corresponds to the Pot 1 shoulder (Figure 6f).

Rim sherd subclass

No one rimsherd subclass appears to correspond entirely to the Pot 1 rim form and decoration. However, rim subclass 6 (Mr6) has several traits in common with the Pot 1 rimsherds. The Mr6 lip is "flat, thickened, and everted (Fig. 22g)," (Byrne 1973:191) as is the lip of Pot 1. The neck is said to be moderately curved, as is true of Pot 1's neck section. The subclass Mr6 rim sherd is said to blend gradually into an elongate globular body; however, Pot 1 has a pronounced angular shoulder rather than blending into the body section. The profile illustrated in Figure 22g (Byrne 1973:681) is similar to the profile of Pot 1 (Figure 6g).

Rim sherd subclass Mr9 is not dissimilar from Pot 1 in form (Figure 6h), and Byrne notes that there may be a single row of circular punctates ca. 3.0 mm in diameter and 3.0 - 7.0 mm apart immediately below or on the neck/collar juncture of this rim sherd subclass.

Discussion

Although the description of the surface finish and subclass attributes seem close to the Pot 1 characteristics, there was some doubt as to whether Pot 1 belonged in Class M. This doubt arose mainly in response to comparison of the Pot 1 surface finish to an illustration of the subclass Mb1 surface finish (Byrne 1973:704, Plate 2d, and see Plate 2d, this paper). If Pot 1 belongs to Class M, then it is as a variant of Class M, due to slight differences in subclass attributes.

Assignment of Pot 1 to the Saskatchewan Basin complex

Paste and vessel form

When Pot 1 is compared to the SBW late variant description, (Byrne 1973:331-335), it fits within the complex. The paste description is fairly broad, and corresponds to the characteristics of the Pot 1 paste. Pot 1 has laminated sherds, a condition defined within the general paste description for late SBW. The temper for the late variant SBW includes very large particles, is predominately granitic (crushed), and varies in density from moderate to large amounts, as does the Pot 1 temper. Coloration of Pot 1 generally corresponds to the coloration described for SBC, except that the Pot 1 coloration has less contrast between exterior and interior surface color and less evident firing core.

Pot 1 has not been reconstructed beyond rim and shoulder so the form of the base and general vessel

outline are not known. The average wall thickness of Pot 1 falls well within the range for SBW, 6.0 mm to 15.0 mm (Byrne 1973:334). The Pot 1 shoulder shape corresponds to a generalized description of late variant SBW shoulders, which are often pronounced and thickened where the shoulder ridge occurs. The neck for SBW is called short, and the same can be said of the Pot 1 neck. Rim forms of SBW are said to slope inward, having usually a concave vertical profile which tends to emphasize the separation of neck from the shoulder. These characteristics occur in Pot 1. The SBW lips are usually flat and thickened, and may be everted. The lip of Pot 1 is flat, thickened and everted, the lip having a slight slope increasing from exterior to interior edge. For a visual comparison of Pot 1 vessel form and late variant SBW vessel form, see Figures 3 and 5.

Surface finish and punctates

The interior surface finish of Pot 1 is smoothed, as is late variant SBW. The Pot 1 exterior surface finish is comparable to each of Byrne's cord-wrapped paddle, fabric/net wrapped implement impression or woven fabric impression categories.

The decorative attributes of Pot 1 coincide with the most common decorative motif for SBW, punctates. A punctate form identical to that found on Pot 1 is described for late variant SBW: "circular with an occasional central cone indicative of a hollow implement," (Byrne 1973:334), forming

an interior boss. Another motif included in the late variant SBW description is oblique impressions on the lip edge, and this feature occurs on Pot 1.

Discussion

Of the four classes of Saskatchewan Basin ware ceramics originally considered for similarity with Pot 1, two classes, Byrne's cord-marked and woven-fabric impressed (Classes A and M), compared most favorably. The basket/net-impressed class was eliminated as a candidate for the Pot 1 designation due to lack of well-defined correlation with the Pot 1 surface finish and vessel form. The fabric/net-impressed class (Class C) was rejected because of its assignment to the early variant of Saskatchewan Basin ware.

The cord-marked and the woven-fabric impressed classes are, as for the other classes originated by Byrne, defined on the basis of exterior surface finish. It appears that either (or both) surface finish description could be applied to Pot 1. In fact, the two classes would appear to be closely associated on the basis of the materials used to achieve the characteristic surface finishes. Cord-marked refers to impression with a paddle wrapped with cordage; the woven-fabric impressed class refers to the use of a fabric of rigid or semi-rigid elements in a twined or plaited weaving pattern. Both techniques refer to cordage applied to the surface after or during formation of the vessel. The way

the two surface finishes differ is in the instrument of impression. In cord-marked, the cordage elements were wrapped around a paddle; in woven-fabric, the cordage elements were woven together.

The lack of exact correlation of Pot 1 with Byrne's SBW classes A and M likely reflects the site-specific nature of his classificatory system. Variation within the class definitions is to be expected as they are defined on one site and applied at other sites. It is proposed that Pot 1 is a variant of the woven-fabric impressed class of Saskatchewan Basin ware.

B. Part Two: The Analysis of Pottery Construction Techniques

The taxonomic analysis of Pot 1 indicates it is a variant of Saskatchewan Basin ware, a classification developed for pottery vessels from southern Alberta (Byrne 1973). The analysis of construction techniques used for the Black Fox Island vessel is attempted here for two reasons. One is to understand the construction techniques used in the manufacture of Pot 1. The reconstruction of the techniques will be based on attributes of the paste, the vessel shape, and marks on the interior and the exterior surfaces. The reconstruction is hypothetical, and could only be proved experimentally or through historical documentation.

Another reason is to compare the hypothetical Pot 1 construction technique with the construction techniques hypothesized for other samples of SBW, to see if a consistent construction technique is suggested for SBC ceramics. Those vessels which were formed using a similar or identical sequence of construction processes could be categorized together into a construction tradition which may or may not coincide with a decorative tradition.

A method and its application

Thanks to the works of pottery analysts such as Shepard (1976) and Rye (1981), archaeologists who wish to deduce techniques of formation of pottery from marks and breakage patterns do not have to experiment with pottery making and breaking. Shepard devotes a section of her chapter on

analysis and description of pottery to evidence associated with pottery manufacture techniques (1976:181-224). Rye (1981:58-95) devotes a chapter to forming techniques and the types of evidence of the manufacture process which appear on pottery. It is, however, easier to understand the connection between construction-related features on archaeological samples and the manufacture process if one has a personal knowledge of pottery-making.

Method of studying forming techniques

The study of pottery vessel forming technique involves obtaining data on visible attributes. Surface marks, fractures, vessel form, and wall contours are evidence used to infer the forming technique. The analysis of vessel forming process can make use of the concept of the essential sequence of pottery manufacture (Rye 1981:58) which holds that some processes or procedures must necessarily have occurred before or after other procedures. A knowledge of forming techniques used in pottery-making is useful to decipher marks resulting from application of those techniques. Coil breaks as evidence of the coiling technique of formation is a well-known example among archaeologists. Determining the sequence of processes of pottery formation is a matter of common sense, and involves a familiarity with tools and techniques and their effects on clay.

A procedure of studying forming techniques is outlined in Appendix 2. This approach was used to infer Pot 1 forming

techniques to compare with those inferred for SBW ceramics. It is based largely on Rye's observations of attributes which indicate forming technique, and his description of the processes which form those attributes. Some of Shepard's (1976:181-191) observations on forming and shaping methods and surface finish are also considered in the analysis.

The method of manufacture of Pot 1 will be reconstructed using information obtained from Steps 1 through 3 listed in Appendix 2. After this reconstruction, the data on the manufacture process of Pot 1 will be compared to the data on manufacture process inferred from a description of Late SBW ceramics by Byrne (1973). What can be inferred of the method of manufacture of the CLP pottery (Hlady 1971: Hanna 1983) will be reported and compared to the technology of SBC ceramics (Pot 1 and Byrne 1973).

Remarks

There may be a problem resident in the comparison of the Pot 1 manufacture technique, as inferred from an actual vessel, with the manufacture technique of SBW as inferred from literature only. The author feels that sufficient data was provided in Byrne 1973 to compare the construction technique of Pot 1 with a generalized late SBW example.

Analysis of forming technique: Pot 1

Step One: Observation

Surface marks

The impressed surface finish of Pot 1 is connected to a step in the forming process. The marks produced by the fabric item in contact with the exterior surface predominate, although several sherds bear marks which deviate from the woven-cord impressed surface finish. These marks include smoothed areas, where the roughened surface texture is obliterated partially or completely; a thin, incised line with several narrow striations running perpendicular to the rim from the lip edge to the broken edge of a rim sherd; and areas where a short, linear impression and longer, thinner striations cross-cut the surface finish.

The interior smoothed surface bears several types of marks. Very faint striations occur in series parallel to one another appear near the rim. Deep striations impressed in the surface appear on random sherds. One body sherd has a distinct incised line running across it. Indentations and depressed areas are evident on the interior surfaces of several sherds. Small discontinuous ridges approximately 10 mm below the lip are evident on the interior surfaces of several rimsherds.

Breakage points, fracture marks and wall thickness

The breakage points of Pot 1 are numerous and random with no apparent correlation between breaks and particular parts of the vessel. The breakage points noted on Pot 1 were caused by normal and laminar fractures. These are breaks occurring perpendicular to and parallel to the vessel wall surfaces, respectively. Usually the laminar fractures are central, half way between the interior and exterior vessel wall surfaces. Small, shallow surface cracks are evident on the interior sherd surfaces, some radiating from pieces of grit visible in the surface.

As determined from the reconstructed rim section and separate bodysherds, the wall thickness is fairly uniform, with the exception of noticeable thickening at the shoulder (neck-body juncture) and the lip edge.

Paste, grit, and orientation of inclusions

The paste of Pot 1 is moderately dense and well-compacted. Compaction of the paste is both laminar and random. Laminar compaction gives the paste the appearance of having parallel layers when observed in cross-section. Using a relative size scale, the grit is predominately small, (including silt-size), and medium particles, with occasional large particles (up to 10 mm). The smallest grit is very fine micaceous particles. The medium-size particles are granitic. The largest grit is pieces of quartzite.

The orientation of the sherd cross-section with respect to the interior and exterior vessel wall surfaces, and also with reference to the rim and base, is important in studying the orientation of particles and voids. Ideally, the cross-section used to look at inclusions in sherds should be cut on a plane parallel to the vessel wall or sherd (see Rye 1981:61, Fig.41). The same thin-sections of Pot 1 used in the mineralogy study were used to observe the orientation of inclusions. These thin-sections were cut on an unknown plane of orientation. A magnification of 25X to 40X was used to observe that four of the five sections contained elongated voids with a moderately parallel orientation to one another. The fifth section had a more random orientation of the elongated voids. The orientation of mineral inclusions and clay minerals in relation to the vessel walls was indeterminate.

Sherd color

An observation of eight complete (having interior plus exterior wall surfaces intact) or reconstructed complete sherds showed that exterior sherd color is predominantly light or medium brown. Interior sherd color is predominantly dark and medium brown. The core color is predominantly medium brown. Approximately the same color scheme is evident for sherds exfoliated with either interior or exterior wall surface intact and sherds exfoliated on both sides.

Some tinges of orange coloration are occasionally evident in all three areas of the sherds. The overall impression is of a fairly uniform coloration of the vessel.

Step Two: Identification of means

Surface marks

The author thinks that the roughened exterior surface finish was produced by the impression of the wet clay with a fabric. It does not appear that the exterior surface was paddled with a cordage or textile wrapped paddle because the parallel grooves and ridges which characterize the exterior surface finish are continuous rather than overlapping or interrupted (see Syms 1979:56-57 for a discussion of the detection of cord-wrapped paddle impression vs. fabric/textile impression).

Plasticine impressions of some of the Pot 1 sherds show that the cordage elements in the fabric were twisted; and the elements were loosely woven, using a twined weave pattern, into a fabric. The cordage used appears to have been of medium rigidity, although flexible. The author has not been able to determine the materials used for the fabric nor the nature of the object used. A basket has been ruled out as the agent of impression. A loosely woven net or bag seems to be the best guess for the agent of impression. If more of Pot 1 is reconstructed in the future, the agent of impression may be more closely determined.

The marks other than the fabric impression, the punctates, and the lip edge linear impressions are random; and therefore may be incidental to the exterior surfaces of the sherds. The isolated areas of truncation of the woven-cord finish on several sherds were produced by an object with a fairly smooth surface. The areas which were smoothed were not large (usually no more than 25 mm). No indentation at the point of contact resulted, so pressure was firm, but light. The thin, incised, striated line evident on a rim sherd exterior (noted above) was produced by a narrow, unpointed object, with a tip of approximately 1.0 - 2.0 mm. Moderate, controlled pressure incised the surface. Short line segments cross-cutting the exterior surface finish resulted from impression by an object 2.0 - 3.0 mm wide. The longer, thinner striations resulted from impression by an object with several strands of ca. 0.5 - 1.0 mm each, or brushing/scraping by an object with a finely nicked edge.

On the interior surface, an object with a finely-nicked edge or with fine ridges was applied with light to moderate pressure, as evidenced by the fine parallel marks or striations. A line was produced by moderately heavy, controlled incision with a tool approximately 1.0 - 2.0 mm wide at the end used. The indentations and depressed areas were caused by a controlled pressure applied with a blunt, moderately heavy tool. The side opposite the point where pressure was applied was supported by opposing pressure. The

small, discontinuous ridge below the lip appears to be the result of folding over of clay so that a slight ledge is formed on the exterior. The ledge is almost imperceptible, and has been obliterated at other areas around the rim exterior.

Breakage points, fracture marks, and wall thickness

The types of fracture present in Pot 1 provide valuable information about the formation process. The presence of "normal" fractures does not appear to be associated with a particular means of formation. They may be associated with direct pressure causing random breakage of a fired vessel, possibly along planes of material (paste) weakness. The primary means of formation associated with laminar fractures are: a) use of strong pressure in forming a slab (Rye 1981:72); b) application of pressure to both walls of a vessel while it is rotated; and c) application of a layer or layers of clay atop another or others. These procedures cause compaction of the clay on a parallel plane. Laminar fractures or exfoliation can occur when the bond of compaction is weak or weakened. A secondary means of formation associated with laminar fracture is beating, either on one vessel surface, with no opposing force; or with opposing force or pressure supporting the opposite wall (Ibid.:85). This procedure causes compaction of the clay on a parallel plane.

Compaction through beating can cause star-shaped cracks to form around the larger-sized mineral inclusions; they will usually show up during drying or firing. This variety of shallow surface cracks is evident on Pot 1.

The numerous breakage points of Pot 1 are seemingly random, and do not indicate points of weakness such as might be present at points of jointure. This lack of selective breakage coincides with the uniformity of wall thickness (Rye 1981:59). The wall thickness of Pot 1 is fairly uniform, except for thickening at the shoulder and lip. The trait of uniformity means that a method of forming was used whereby thickness of the wall could be observed and controlled. The thickening of shoulder and lip occurred through application of more clay in addition to the standard vessel thickness. This feature could have been created through folding, overlapping, or simple addition.

Paste, grit and orientation of inclusions

Compaction of the paste to a moderately dense state, and the presence of laminations within the paste, indicates firm pressure on the clay during formation. The elongated voids, seen magnified in thin-section, are oriented parallel to one another, indicating that an opposing force was applied perpendicular to their direction while the clay was plastic (see Rye 1981:61).

The grit, or temper, appears to have been sorted with respect to size since small and medium grit is predominant.

Occasional large (5 - 10 mm) pieces of grit were present, and presumably were not incompatible with the forming technique.

Color

The color of Pot 1 may have changed from its original post-firing color through usage or depositional conditions (leaching, weathering, etc.). Therefore, the specific color is incidental. The more general attributes of uniformity of coloration and the observation of occasional orange tinge are more meaningful. Uniform color implies a uniform firing atmosphere. The incidental variation to orange tinge on some sherds indicates they were subjected to different conditions. Color and the production stage of firing will not be further considered in this study.

Step Three: Interpretation of the vessel construction sequence

Primary and secondary forming procedures

The primary forming evidence includes features which indicate pressure was used to initially shape Pot 1. A number of features of the Pot 1 remains indicate that molding was the primary forming procedure used, in conjunction with controlled pressing or beating of the walls. The "uniform -textured surface" of the exterior is one indication of formation in a mold (Rye 1981:81). The exterior roughened surface bears the imprint of the interior

surface of the mold into which the clay was pressed. The fact that the rough exterior surface is largely unmodified indicates the clay was placed in the mold in a plastic state and removed when fairly well dried. The smoothed interior surface bears indentations and small depressed areas where pressure was applied to form the walls against the support of the mold.

As stated, the primary formation methods associated with laminar fractures use pressure, causing compaction on a parallel plane. The slab building technique can result in laminar fracture, as can the technique of throwing on a potter's wheel (Ibid.:72, 80). Application of a layer or layers of clay to the inside of a mold, using pressure, can also result in laminar compaction and fractures. The shape and size of the vessel, as inferred from the rim diameter of the vessel, is consistent with a molding technique (Rye 1981:81).

The thickened shoulder area resulted from one of two different procedures during the primary forming stage. It may have been thickened by adding clay to the angular, or bowed section of the shoulder at the neck/body juncture to keep the interior surface at a level consistent with the rest of the interior, thus strengthening a potentially weak area. Alternatively, the thickened shoulder may have resulted in the event of overlapping the neck with the body at the shoulder section. This juncture could have been smoothed to obliterate joining traces. A pattern of "normal" breaks,

perpendicular to the walls, is not present to reveal a weakness at the shoulder of Pot 1, as would occur at an inadequate jointure. Laminar fractures are evident at the shoulder. The fractures are central to the interior and exterior surfaces. This trait may indicate application of clay atop a base layer of clay at the shoulder area.

Refining the initial shape of the vessel is the second stage of formation. The thickened lip was formed during the second stage. After the neck was formed, the top of the vessel, or rim, was folded over upon itself, or a flattened strip of clay was folded over the rim edge. The folded portion overlapped upon the exterior of the vessel, and the resulting ridge was mostly smoothed out to form a lip continuous with the neck.

Beating is used for secondary formation, and it may account for the laminar fracture pattern characterizing Pot 1. A number of features observed on Pot 1 are associated with the technique of beating. Beating may be used "to pack clay into or over a mold" (Rye 1981:84). Beating is also applied to refine shape. Some inadvertent results of the beating technique are depressions, called anvil marks, on the interior surface (Ibid.); laminar fracture; star-shaped cracks around grit; and orientation of voids parallel to the surfaces (perpendicular to the points of application of pressure).

Step Four: The reconstruction of vessel formation process

A reconstruction, or interpretation, of how Pot 1 was manufactured will be attempted, based on the information detailed above. Refer to Table 1 for an abbreviated notation of the raw data used to arrive at this reconstruction.

A. Procurement and preparation of materials

The clay was obtained, and granitic rocks were ground to produce temper of the required size. It seems that care was taken to ensure that the ground granitic temper was under 4.0 mm in size, although there are occasional fragments over that size. The required amount of temper was kneaded into the clay. A medium size (ca. 20.0 - 30.0 cm in diameter and ca. 10.0 - 15.0 cm in depth) round pit was dug into the ground, and lined with a loosely woven fabric. The shape of the fabric or net dictated it had to be folded over itself in some places to correspond to the rounded pit shape.

B. Primary forming

The prepared clay, or paste, was placed inside the pit as a lump. A hollow was punched into the middle of the lump, and the potter began to press it upward against the sides of the pit. To facilitate the molding operation, a medium size (ca. 8.0 cm), rounded cobble was used to press and/or strike the clay wall interior to force the clay walls upward from the base. A beating technique served to press the clay into the mold surface, compacting the walls and impressing the

exterior wall surface with the cordage pattern. As the walls became thinner, the potter decided to add a second layer of clay paste atop or inside the original wall. This second layer was added uniformly. It probably was formed much as the original wall: started from a lump of paste and worked, through beating, upward inside the pit.

Once the base was formed, the potter formed several thick, flattened, rectangular slabs (flattened coils) from the prepared paste. These sections were to be added atop the base to form the neck. The edges of the woven cordage lining the pit were drawn upward so that the surface finish of the base would be continued on the rest of the vessel. The slabs were joined to the edges of the base, and the line of jointure was carefully smoothed so that it was not evident on the exterior. The slabs were tilted slightly inward from the base so that when the slabs were joined together the neck was constricted. The shoulder area, when the base and neck were joined, was thickened so that a smooth transition rather than a bowed effect was present on the interior wall. This action served to strengthen the juncture point. As the neck was built upward through addition of slabs of the desired neck width, the neck section was pressed against the fabric. The potter applied the rounded cobble as a support inside the pot, and the potter's other hand applied opposing force as it pressed the vessel exterior during the neck formation process.

C. Secondary forming

The final step in the formation process was to finish the neck edge, or lip. One possible means employed a long strip of clay, thinner than the existing wall, applied atop the existing neck edge; and the strip was folded over to extend slightly downward over the interior and exterior walls. It was then compressed into the edge or rim of the vessel, and the edges of the strip were smoothed into the walls on both sides. Alternatively, part of the neck edge was folded over on itself, to form a more even edge, and the selvage ends smoothed into the exterior surface. By one of these two means, the lip was thickened, and the top of the lip had an even and finished surface. The fabric was pressed up over the neck and into the top of the lip.

The finishing touches were applied not long after the vessel was formed. The interior lip edge was impressed or "crimped" with a small, smooth stick or bone, or possibly even with the potter's thumbnail. Punctates were impressed into the neck after the fabric was rolled down or moved aside to admit the tool, a smooth, rounded stick or small bone. A small stick was used to scrape longitudinally across several of the bosses on the obverse side of the punciates, resulting in holes through the vessel wall. The pot was allowed to dry to the leather-hard stage before it was lifted from the pit and the fabric removed, resulting in an unmodified, roughened surface.

Summary

A method to identify pottery manufacture techniques and procedure was applied to Pot 1. The method was explained in detail, and applied to the analysis of Pot 1 in the format detailed. In this way, the logical connection between the observation of pottery features or traits, and the interpretation of manufacture method, is explicated. It is proposed that this format for the analysis of pottery technology may be applied to other archaeological ceramic specimens and also to literature descriptions of ceramics, as long as the appropriate information is present in the description.

In the following section, the format outlined in Appendix 2 will be used for a construction technique analysis of late variant SBW as described by Byrne (1973). Byrne's observations of certain characteristics of SBW ceramics will provide the data used for the analysis. The report of the SBW structural analysis will be more abbreviated than the preceding report of the Pot 1 analysis, although all the steps detailed above will be followed.

The analysis of the forming technique: SBW ceramics

Byrne's classes A (cord-marked) and M (woven-fabric impressed) were the closest in surface finish and paste description to Pot 1. See Table 1 for the raw data used to identify the means, interpret the sequence, and reconstruct the process of ceramic manufacture.

The construction procedure summarized for these classes of SBW will be compared and contrasted to the construction procedure hypothesized for Pot 1. More than one technique of manufacture may be used in any one pottery assemblage. This variation should be evident once construction technique is analyzed. It may also be suggested by a casual inspection of vessel form.

The author observed and recorded structural features for several randomly selected body sherd samples from the Morkin site (DlPk-2) stored at the Archaeological Survey of Alberta (ASA). The sherds were selected on the basis of similarity of their surface finishes to that of Pot 1. These sherds were observed to familiarize the author with ceramics from the Morkin Site (DlPk-2). They do not figure prominently in the interpretation of Late SBW ceramic construction technique.

Indications of forming procedure: Observation of sherd features, identification of means, and interpretation of sequence

Surface marks

Saskatchewan Basin complex Class A and Class M ceramics, and the selected specimens from the ASA collection, have exterior surface impression, a feature which indicates that the clay was pressed against or beaten with a surface having relief. Byrne's descriptions of Classes A and M indicate that a cord-wrapped paddle or a

woven fabric agent likely caused the impression. The ASA specimens have impressed linear marks which could be associated with a fabric. The linear marks are smooth (no cord twists).

The interior surface of Class A ceramics is described as smooth and regular with so-called anvil marks, or shallow depressions. Class M interior surface is described as smooth with broad, horizontal stria. The interior surfaces of the ASA specimens were smooth. All descriptions seem to indicate smoothing of plastic clay with a soft tool.

The other surface marks associated with the Class A subclasses most similar to Pot 1 are: a row of circular punctates on the shoulder; cord-wrapped stick impressions on the interior and exterior surfaces; and narrow linear impressions on the neck and elsewhere. For Class M, finger pinchings, fingernail impressions, smooth rounded depressions on the lip, and punctates are characteristic. No decorative surface marks were evident on the ASA sherds.

The average thicknesses for sherds of Classes A and M are ca. 7.0 - 9.0 mm. The ASA samples range from 10.0 - 20.0 mm in thickness, averaging 15.0 mm. Several rim subclasses of M feature thickened lips, and the shoulder subclass has a well-developed shoulder ridge.

The Class A ceramics have well-compacted paste and some occasional laminations and blockiness (Byrne 1973:32). The same features characterize the paste of Class M ceramics (Ibid.:186). The ASA specimens have well-compacted paste but

no laminar fractures, although one sherd cross-section showed laminar splitting. In general, the paste of the ASA specimens had a laminated or layered appearance, attributable to the application of pressure. Normal perpendicular fractures were noted for the ASA specimans. The angular quartz and feldspar temper of the Class A, Class M, and ASA specimens are small and medium sized. Byrne states that the Class A mineral inclusions do not exceed 6.0 mm in size. Fine micaceous particles were observed for the ASA specimens.

Based on the features noted above for the Class A, Class M and ASA collection ceramics, the SBW vessels represented were most likely formed by the procedures of molding and associated pressing. The absence of depressions on the interior surface of Class M sherds indicates that probably a beating technique was not used to pack the clay into the mold and force it upward. Anvil marks on Class A sherds indicate that pressing with an anvil stone may have been the means of packing the clay into the mold. It is also possible that such marks as would result from beating were later obliterated by smoothing over with a soft item to which pressure was applied.

Pressure during the molding process was firmly applied, resulting in a good degree of compaction, as evidenced by the lamination and the denseness of the paste. The secondary forming procedure may or may not have involved beating. The secondary forming procedure did employ smoothing of the

interior, firmly by hand or with a soft cloth (leather?). When the vessel was completed, the decorative finishing touches were made.

Byrne (1973:332-335) presents some reconstruction of the manufacture process for the Saskatchewan Basin complex in general. The interpretation presented above agrees for the most part with Byrne's analysis. He states that the interior surface was smoothed either while the clay was still plastic or when it was partially dry, causing the uniform smoothness and a few parallel striations. He states that many of the samples were not paddled, or beaten (Ibid.:333). The majority of the SBC ceramics have modified exterior surface impression through smoothing while plastic, or through truncation (allowing the surface to dry to leather hard and then scraping it). Some were unmodified. Most vessels were of a rounded shape which might be indicative of pit or other molding procedures. The shoulder ridges (neck/body junction) were internally or externally thickened. The necks are short. Rims are generally insloping. The lips are generally flat and thickened.

Based on the author's interpretation of Byrne's written description for some SBC ceramics, together with Byrne's discussion of forming technique, a reconstruction of a process used to manufacture SBC ceramics is proposed. The variation of form and design as reflected by the different classes within the SBW complex suggests that there were variations on this method of manufacture. However, it

appears that at least some of the SBC ceramics were formed by the molding process, whereby clay was pressed into the sides of a shallow, medium-size rounded pit lined with net or other woven cordage. The clay may have been beaten with a cobble to press it into the side. More likely it was pressed firmly by hand, and the walls were worked upward by manual pressure. The inside walls were smoothed as they were built upward. The walls were made fairly thick as the potter moved the clay upward inside the mold. More clay was added to the lump with which the potter had started. With the wall thickness of ca. 10.0 mm, grit particles up to 4.0 mm in size were inconsequential.

Once the base was formed inside the mold, flattened coils of clay were added to form a neck. These long, narrow slabs were tilted slightly inward as the neck was formed, resulting in an angular, bowed shoulder. The neck/body juncture, or shoulder, was thickened and strengthened through the addition of clay to the inside or outside of the shoulder area. In the case of Class M vessels, as the neck was built upward, the fabric was drawn upward and pressed into the neck to continue the impression formed on the base. The top of the neck, or lip edge, was thickened by adding clay or folding the neck edge over itself.

The lip edge was flattened, or squared off. After forming, decorative motifs were added, using various tools. The pot was allowed to dry to the leather-hard stage before it was lifted from the pit and the woven cordage removed,

resulting in an unmodified, roughened surface.

Vessel formation processes and inferred contacts of potters with potters

The primary forming technique has been reconstructed for Pot 1 and some classes of SBC ceramics as described by Byrne (1973). The author has suggested that some SBC ceramics were molded inside pits lined with woven cordage. The clay would have been firmly pressed along the sides of the mold to form the vessel walls. A fabric lining in the pit was probably intended as a parting agent, and it caused a roughened surface finish for the vessel exterior. The technique of beating is strongly suspected for the compaction of the clay into the mold for Pot 1 (based on interior anvil marks). Pressing or another method of compaction into the mold is suspected for the SBC samples cited here. Whether by beating, or through the application of firm pressure by other means (pressing), laminar compaction is evident in the pastes of Pot 1 and the SBC samples examined, indicating stress applied parallel to the vessel walls during manufacture (Rye 1981:85).

Vessel formation processes and vessel form

The fact that vessel formation attributes along with decorative/surface finish attributes coincide for Pot 1 and several classes of SBC provides more evidence that Pot 1 belongs within the SBC category. Some processes of vessel

formation influenced the formal attributes of Pot 1 and some classes of SBC ceramics. The average thicknesses of the walls of Pot 1 and SBC samples are ca. 10.0 mm. Wall thickness represents a conscious decision of manufacture on the part of the potter. It can reflect the strength of materials and the size of the vessel. However, the ultimate decision of how thick the walls will be rests with the potter and her/his technical knowledge and observance of traditional norms for ceramics manufacture. It seems the potters' decision criteria for wall thicknesses of Pot 1 and SBC ceramics were similar.

The shoulder form of Pot 1 is similar to that of several classes of SBC ceramics, including Class M. The distinctive carinated, sharply angular shoulder ridge was the result of a distinct formation process in joining the body and the neck (see above). The wall at the point of the shoulder was thickened to strengthen it and even out the interior surface. A similar or shared technical approach to shoulder formation is suspected for Pot 1 and certain SBC ceramics. Thickened lips appear on Pot 1 and samples of some classes of SBC ceramics. Features associated with the thickened lips on Pot 1 and the SBC ceramics lead the author to propose that they were formed by folding over the neck edge.

Decorative attributes are cosmetic rather than inherent in the manufacture process. Decorating a vessel with punctates around the rim or neck to emulate a motif seen on

the work of other potters can indicate a significant historical connection, or it can be a matter of casual imitation of a design observed with little or no actual contact between persons. The technique of manufacture has to be observed in process, or taught, involving direct contact of one potter with another. Emulation of manufacture methods implies more of a teaching-learning process than does emulation of decoration. A similar line of thought has been expressed by Young and Bonnichsen in their study of cognitive correlates of stone tool manufacture (1984:7).

A decorative component of a vessel may result from a primarily technical activity. An example of this interrelationship is the fabric-impressed exterior surface of Pot 1 and SBW ceramics. Systems of pottery classification need to be set up to recognize and acknowledge the relationship between decoration and other vessel features, and vessel formation processes.

The comparison of forming technique: the Saskatchewan Basin complex and Clearwater Lake Punctate type

In the study of cultural continuity and interrelationship, it has been proposed that technologically-linked traits are potentially as important as traditionally used stylistic traits (Hickey 1984:28). Of interest to the cultural interpretation of Black Fox Island prehistory is the potential relationship of SBC ceramics of the southern Alberta plains to the CLP type ceramics which

have been associated with Woodland Cree movements in the southern boreal forest of Manitoba and Saskatchewan (Hlady 1971:21). A link between SBC and the Saskatchewan and Manitoba Selkirk phases has been proposed by Byrne (1973:405-407). This link is proposed on the basis of stylistic and temporal considerations.

However, it may be that stylistic and temporal features are not the only possible evidence of a relationship between the two pottery complexes. As seen with Pot 1, initial examination led to some confusion in assigning the correct typological name to the Black Fox Island vessel (McCullough 1982). The author feels that it is entirely possible, and probable, that a link between SBC ceramics and CLP pottery does exist. The archaeologist sees this link in the shared decorative motif of punctates and the use of fabric as a parting agent, a technological practice which has an effect on the surface finish.

The potential utility of construction technique analysis to supplement the usual ceramic classificatory data to arrive at the correct type assignment was demonstrated in the analysis and the reconstruction of the technique of manufacture of Pot 1 and SBC ceramics. A comparison of technological attributes generalized for late SBC ceramics (see above) and of technological attributes of CLP ceramics from site FhNa-10 will be made here. This comparison based on descriptions from the literature will provide some very preliminary data to show some directions for exploring the

SBC - CLP (Selkirk) link.

Construction technique analysis of Clearwater Lake Punctate pottery

Several CLP samples (here designated Pots A-E) from Bushfield West (FhNa-10), near Nipawin, Sask. were observed and described. The descriptions will be used to reconstruct the method of manufacture of CLP pottery. See Table 1 for a sample of the raw data used in the reconstruction. Reference will be made to Hlady's (1971b) and MacNeish's (1958) descriptions of CLP ware. Reference will also be made to Hanna (1983b), who has reconstructed the probable method of manufacture of FhNa-10 Vessel 5.

Surface marks

The exterior surface finish of Bushfield West's Pots A-E and of CLP type generally is truncated fabric- or cord-impressed. The pattern is usually uniform, and covers the entire exterior surface of the vessel. The interior surfaces are smoothed and have striations. Hlady does not describe the interior surfaces of CLP, but MacNeish describes the interior surfaces of Winnipeg Fabric-Impressed ware as "carelessly brushed smooth with a horizontal motion" with basal (finger) depressions (MacNeish 1958:166). Hanna (1983b:31) indicates that the vessel she examined (FhNa-10:5) has shallow depressions on the interior surface. Small depressions are evident on the interiors of several of

the other FhNa-10 vessels (Pots A-E) sampled. Hanna also notes a "cluster" of probably unintentional small (1.0 - 1.5 mm) holes on the interior and exterior rim surfaces. The vessel has punctates and a fabric-impressed exterior surface finish.

Breakage, fracture and thickness

Laminar splitting or breakage does appear occasionally for Pots A - E. Normal fractures are characteristic. Small star-shaped cracks radiate from grit particles on the interior surfaces. Hlady does not mention breakage or fracture except to note that there are no coil breaks (Hlady 1971:7). MacNeish mentions that Winnipeg Fabric-impressed ceramics are characterized by "numerous laminations" (MacNeish 1958:162). Besides the normal fractures evident for Vessel 5, Hanna (1983:35) mentions firecracks on the exterior base; star-shaped cracks around temper inclusions; and spalling.

The range of wall thicknesses of Pots A - E is 2.0 to 8.5 mm, depending on which section of the vessel was measured. The lips were consistently flattened and generally squared. CLP pottery is, according to Hlady (1971:16) 4 to 11 mm thick. Hlady notes that CLP lips are flattened, and he seems to imply thickening (Ibid.:7).

The shoulders of Pots A - E are not thickened. The shoulder form is pronounced but not angular. MacNeish calls the shoulders of CLP "slightly angled" (Ibid).

Paste and mineral inclusions

The paste and mineral inclusions of CLP are medium to coarse with medium sand/grit and medium to coarse crushed granite particles. Similar attributes of paste and inclusions are noted for Pots A - E. The orientation of voids or inclusions is not noted because thin-sections were not available.

The identification of the means and sequence of construction

Several features observed for Pots A - E, and the descriptions of CLP and Winnipeg Fabric-impressed ceramics, suggest the use of directed pressure in the primary forming method. The paste, although coarse and friable, is usually well-compacted or consolidated to form dense, hard interior and exterior surfaces. Slightly laminar compaction is evident in the paste. The exterior surface impression suggests formation inside woven cordage. Depressions on the interior surface, especially near the base, indicate pressing with fingers on the interior surface to compact and mold the walls upward. Firm pressure to the vessel walls as they were built up is indicated by the laminar compaction.

Some structural observations of the FhNa-10 pottery provide further evidence for the technique of manufacture. On two of the vessels examined, the shoulders appear continuous with the body, as though they were molded in one piece with the body. On these specimens the shoulders are obvious but not overly pronounced. On another vessel, the

shoulder was more discontinous with the body and much more pronounced, or angular. Striations, evidence of smoothing, indicated that the base and neck areas may have been joined at the shoulder of the vessel with the angular shoulder rather than having the shoulder molded as part of the body.

The partial obliteration or smoothing of the exterior surface finish indicates that the pots were removed from the fabric while still in at least a partially plastic state. The surface finishes are fairly uniform and continuous over the entire vessel surfaces, meaning that fabric was applied to to the entire vessel while it was manufactured, before removing it from the mold. Before the surface impressions could "set" by completely drying while in contact with the cordage, the vessels were rubbed or wiped, flattening the impressed surfaces.

Reconstruction of the manufacture process

The potter combined clay and tempering material to form the paste. A fabric item was on the exterior of the vessel walls while they were built upward. The vessel may have been inside a support during its formation, with the potter very firmly pressing the paste and drawing it upward to result in thin, well-compacted walls. Only one application of the paste to the mold was made. A technique of gentle paddling or pressing the free-standing but fabric enveloped paste, using the hand (fingers) inside as opposing pressure, is another possibility for the initial molding technique.

For some of the vessels, the body and shoulder were molded and shaped as one piece. The neck was added in a slab technique (flattened coil pieced on), and the jointure was smoothed. The woven cordage was drawn up over the neck, to result in overall cordage impression. For other vessels, the shoulder was added to the base, using the slab technique mentioned above; and the jointure line was smoothed. The neck was added using the same technique.

After the initial shaping procedure, and following a short period of drying until it was firm enough to be self-supporting, the vessel was removed from the fabric enclosing it (and the mold support, if present). Secondary and final forming processes were then enacted on the vessel. Further pressing or gentle paddling was applied to the vessel walls to thin and compact the walls more firmly. Handling of the vessel exterior while the paste was still plastic began to obliterate the fabric impression. The interior and exterior surfaces were smoothed and almost polished by wiping, possibly with a damp piece of leather. The lip was flattened and smoothed, using a finger moistened with water. Decorative elements were then applied to the rim.

In Hanna's reconstruction of the formation process for FhNa-10:5, the potter hollowed out a lump of clay paste and used a drawing technique to form the vessel initially, then paddled it to shape it further and thin the walls. At this point, the vessel was placed into a mold lined with fabric

while the potter completed the neck, shoulder, and rim. In order to continue the impressed finish over the entire vessel, the fabric was drawn upward and applied to these newly-added parts (Hanna 1983b:33).

The main difference between the author's interpretation for Pots A-E and Hanna's interpretation for FhNa-10:5 is the issue of whether the vessel was initially formed inside a mold and then pulled out and forming steps continued, or if it was initially formed outside a mold and then placed into one. Hanna states a good structural rationale for completing formation of the vessel inside a mold: the walls become unstable as they are formed upward to the point where a shoulder and neck will be added (1983b:31). At this point, it is open to conjecture whether or not the vessel was supported in the mold from its inception or after initial shaping.

Summary

The manufacture process of the CLP variant (Selkirk ware) pottery vessels from FhNa-10 observed by the author appears to have some similarities and some differences with the southern Alberta plains manufacture process reconstructed above for Pot 1 and several SBC samples. The generalized reconstructions of SBC and CLP ceramics elicit technical information which underlies the stylistic similarities and differences usually considered in comparison of the two wares. In general terms, the

technology of the two wares was similar, for both employed molding and application of pressure in the initial forming stage, as opposed to any one or several of the other hand modelling techniques (Rye 1981:66-81) available to potters.

The molding technique influenced the forms of the vessels and their exterior surface finishes. The shapes of the molds in which the bases were formed were rounded, resulting in rounded or globular forms. In order to fashion the constricted neck and sometimes a pronounced or angular shoulder characteristic of the two ware varieties, a suitable method of adding pre-formed pieces of clay to the base was employed. Fabric was employed as a parting agent between the paste and the mold support, and caused the characteristic exterior surface finish. This parting technique is an obvious and arguably significant similarity between the two wares. Other materials can be used as effective parting agents, including sand, powdered clay, ash (Rye 1981:81) or other fabric such as leather (Simon 1979:53). The shared choice of fabric over other suitable and readily available materials implies a shared technical knowledge and/or cultural preference.

The author has suggested that the beating technique was used on the interior surface of Pot 1, and other SBW ceramics, to compact the clay and distribute it throughout the mold. This beating was effected while the pot was still enveloped in the fabric, either inside or outside the pit. If inside the pit, the pit walls would have provided the

opposing force. Pot 1 and the other SBW ceramics described for this study show clear signs of a beating technique. The FhNa-10, CLP variant vessels observed have signs of fingers pressed into the interior, but no anvil marks.

III. Chapter Three - The Chemical and Mineralogical Analyses of Pottery

A. Part One: Chemical Analysis of Pot 1

Hypothesis 1:

Pot 1 of site GfPa-32 was manufactured on Black Fox Island of local clay.

The pottery found on Black Fox Island could have been manufactured on Black Fox Island. If the results of chemical analysis and comparison indicate that Pot 1 had been made of Black Fox Island clay, there is no need to look for a matching clay source elsewhere. Testing of Hypothesis 1 is an obvious step in the investigation of the process by which Pot 1, a Saskatchewan Basin ware variant vessel, came to be on Black Fox Island.

Two of the assumptions of H1 are as follows:

1. If clay suitable for pottery-making purposes is present on Black Fox Island, it would have been used for prehistoric pottery manufacture. The premise that known deposits near the site of manufacture and/or use will be utilized is based on the ethnographically documented "principle of least effort" (Rye 1981:12). Thus, if the Black Fox Island occupants were potters, and if they required a new pot at that time, they would have manufactured Pot 1 locally, of a suitable nearby clay source.

2. If the chemical compositions of the clay and Pot 1 match, clay from Black Fox Island was used to make the pot. The natural mineral inclusions of the clay and the pottery should also match. The culturally introduced, or temper, inclusions are not considered in the examination and comparison of two potentially alike clays.

The above two implications were considered in testing and comparing BFI clays and the pottery. The tests involved a) finding clay on the island; b) testing its suitability for pottery manufacture; c) determining the chemical compositions of clays and Pots 1 and 2; d) comparing the chemical compositions of the clays and the pottery; and e) observing and comparing the minerals contained in the clays and the pottery.

Ceramics analysts have been aware of the utility of chemical and mineralogical studies in characterizing pottery composition "for some time now." (Hanna 1982:36). Hanna, in a chapter entitled "Chemical and Mineralogical Ceramic Analysis: Case Studies" mentions two of the earliest studies, Shepard 1936 and Drier 1939, for mineralogical and chemical analyses respectively. Thin section, or mineralogical analyses, were conducted even earlier, according to Bower 1973. Hanna details a number of case studies which used X-ray fluorescence, X-ray diffraction, neutron activation, optical spectroscopy and thin-section analyses. She focuses on North and South American studies as being most relevant to her discussion. The case studies she

mentions will not be reiterated here, but her summary will be recommended as an authoritative catalog and description of the use of geochemical and mineralogical analyses for the study of pottery technology and for comparative purposes.

The aims of chemical analysis

Chemical analysis allows pottery and clay source samples to be characterized according to the elements contained and the concentrations of each element contained. Once a sample has been characterized according to its chemical content, it can be compared to other samples on the same basis. The basis for comparison of chemical composition of one pottery sample with another involves the assumption that the clay used to manufacture a ceramic piece is derived from a locale with a distinctive geological history. The distinctive geological history will have resulted in a distinct chemical character for the clay deposit. Thus, two ceramic items can be compared; and even though their exact clay source locations may not be known, if the two items are chemically the same, they could be said to have been made from the same clay. Chemical analysis can also be used to compare pottery with raw clay to try to determine the source of raw materials for pottery manufacture.

The usefulness of chemical analysis depends on the research objectives. Geochemical analysis is generally too expensive to be done just for the sake of having a chemical "fingerprint" to describe a ceramic sample. Eventually, the

collection of chemical fingerprints of ceramics may become a research objective in itself, to compile data for regional comparative purposes. To date, geochemical analysis is conducted to address a particular research problem or problems. (See case examples for INAA, below).

Some techniques of chemical analysis

A number of chemical analysis techniques have been applied in the study of prehistoric ceramics. Each technique has its strong points and limitations when used to characterize the chemical composition of prehistoric pottery and/or raw clay. The other techniques reported in the literature on pottery-clay provenience analyses have been the standard optical spectrograph technique; X-ray spectrography techniques, including X-ray diffraction and X-ray fluorescence; and neutron activation analysis. Other techniques which have been used to a lesser extent are proton-induced X-ray emission (PIXE), electron microprobe analysis, and X-ray absorption. Each of these techniques is not used singly, but in conjunction with other qualitative and quantitative techniques of characterizing the composition of the ceramic or clay samples.

The standard optical spectrograph technique

The standard optical spectrograph technique (Freeth 1967:105) was one of the initial and more rudimentary techniques of qualitative chemical analysis used for

archaeological pottery samples (see, for example, Hartley and Richards 1959; Musty and Thomas 1962; Catling, et al., 1961). Shepard (1961:143) explains the principles of spectrographic analysis as follows: A specimen is bombarded by a stream of accelerated electrons in a discharge tube or electric arc. Light is emitted, and the resulting characteristic spectral lines are analyzed to identify the element. Spectrographic analysis has advantages, according to Shepard, in that it is easier to effect and is more sensitive to trace elements than separation of elements in solution (Shepard 1976:144). There have also been recent improvements in the technique (L.G. Stephens-Newsham, personal communication).

X-ray spectrography

The X-ray spectroscopy techniques are advantageous over optical spectroscopy because they are faster, easier to interpret, and more accurate (Hanna 1982:146). As in optical spectroscopy, a specimen is bombarded by an electron beam, resulting in emission of X-rays from the inner orbits of the elements (Gould 1971:42). Bombardment is carried out in a vacuum discharge tube, and utilizes very high energy electron beams (Ibid.; Ewing 1969:46). The resulting X-ray spectra are simpler than optical spectra, and are analyzed by a spectrometer (Ewing 1969:196;197).

X-ray fluorescence is a modification of X-ray spectroscopy, and involves excitation of characteristic

X-rays by a more energetic beam of X-rays rather than by an electron beam (Gould 1971:47; Ewing 1969:13). X-ray diffraction is used to identify crystalline structure and compounds such as the oxides which occur in clay (Ewing 1969:205). The technique makes use of the grating-like effect of the crystal lattice to scatter X-rays in specific directions.

Other X-ray methods

Electron microprobe analysis uses a finely focussed beam of high-energy electrons, which is trained on the sample surface, to excite the characteristic flourescent X-ray spectra. The sample can be characterized through element identity and quantity (Gould 1971:51,507).

The X-ray absorption technique is based on the fact that all matter absorbs X-rays to some extent and a beam of known energy will be selectively absorbed by certain elements, permitting chemical analysis in some cases (Gould 1971:51).

Proton excited X-ray emission (PIXE) uses a proton beam, several MeV in strength, focussed on a sample to excite the emission of X-rays from the sample's surface layer (Rye 1981:59-60). The method is used to identify elements at the middle and upper end of the periodic table (L.G. Stephens-Newsham, pers. communication).

Activation analysis

Neutron activation analysis utilizes the principle of radioactivity (Ewing 1969:372). The elements of a substance are bombarded with neutrons, resulting in the formation of unstable, radioactive isotopes. The radioisotopes decay according to a well-defined time constant, termed the half-life. Energy emitted by the decay of the radioisotopes, in the form of gamma rays, is measured by a spectrometer. The elements can be identified by the energy of the gamma peaks (Duke 1983:5). The photopeak intensity or size is measured relative to the mass of the element from which the radioisotope is derived. The elements can also be quantified. There are at least two limitations for the technique. One is that some elements do not readily produce radioisotopes. Secondly, some radioisotopes have a half-life too short to analyze.

Case examples of neutron activation analysis

The following section contains case studies used to evaluate the use of neutron activation analysis (NAA) in chemical comparisons of clay and pottery. NAA is conducted via laboratory instrumentation, and is thus often referred to as instrumental neutron activation analysis (INAA).

Perlman and Asaro (1969) provide a definitive article on the technique of neutron activation analysis applied to the chemical study of pottery. They discuss the mechanics of the technique, and how the results are calculated to arrive

at conclusions about the chemical composition of the pottery. They also report how the technique was used to approach a couple of specific archaeological problems (Perlman and Asaro 1969:34-37). They note that the technique is sensitive to detecting minor components, or elements, and that "many elements can be determined simultaneously." (Ibid.:21). These two criteria are essential for optimal characterization of pottery samples.

The Perlman - Asaro technical discussion of neutron activation was timely, as the technique was beginning to come into wider use. They explain some of the problems inherent in detection of elements and subsequent interpretation. One of their contributions was to establish "standard pottery." The calibration of elements contained in one pottery sample may be used as a standard for quantifying elements in other pottery samples, rather than using pure substances as the standard. They also demonstrated that the technique can show correspondence or similarity between sherds from one vessel, and to differentiate between sherds from two different vessels (Perlman and Asaro 1969:30).

Perlman and Asaro were interested in establishing provenience based on chemical composition of pottery. Stylistic criteria do not always accurately reveal provenience. They did not compare raw clays to pottery because they felt it was not practical in their situation, but they indicate that such a comparison has potential (Ibid.:35,36). INAA has been often applied to ceramics from

Near Eastern, Mediterranean, and Mesoamerican archaeological sites. Economic relationships indicated by importation and exportation of ceramics are often the concern of the analysis. This concern translates to a question of provenience of source clays from which the ceramics were made. A look at the approaches to discover the proveniences of source clays can provide some guidelines for the Black Fox Island project's clay-pottery comparison.

Ceramics from the Valley of Mexico (Abascal-M., et al.1974:81) provide a provenience-related problem. Many sherds of Oaxacan-style pottery, said to originate 400 km south of Teotihuacan, were found in Teotihuacan. Was the pottery transported from Oaxaca or was it manufactured in Teotihuacan, of local clays in the Oaxacan style? Oaxacan sherds from near Oaxaca, Oaxacan-style sherds from Teotihuacan, and clay from a present-day potter's source near Oaxaca, as well as typical Teotihuacan-style pottery, Teotihuacan clay and modern Teotihuacan pottery and Oaxaca-Teotihuacan hybrid style pottery were all analyzed using neutron activation. The results show agreement among all the archaeological pottery samples from Teotihuacan, including the Oaxacan-style sherds (Ibid.:89). Furthermore, the modern pottery and clay from Teotihuacan matched the archaeological samples, indicating that all the pottery found in Teotihuacan was made locally. The Oaxaca area pottery and clay also form a group of similar composition. The actual clay sources for the archaeological pottery were

not located during this analysis, but the general clay source area is indicated.

In general, NAA is shown to be effective in a) chemically differentiating between ceramics of varied origin; b) indicating chemical similarity of ceramics thought to be from one location; and c) correlating archaeological pottery samples with modern clay to indicate provenience of raw material source. Besides reporting on their results, Abascal-M., et al. explain the procedures of analysis and statistical interpretation (1974:86-88). Of particular interest to the Black Fox Island study is the discovery that the temper in the pottery did not skew the chemical results and that postdepositional change in the pottery was negligible (Abascal-M.,et al. 1974:90).

The archaeological problem at Teotihuacan addressed the presence of seemingly intrusive ware on a site where most of the ceramics appeared to have been locally manufactured (Hammond, et.al. 1976:147). The conclusion to this problem confirms that the four major ceramic types are of local manufacture, as they clustered most closely with samples of local clay (Ibid.:156). The authors thoroughly present the technical information of the neutron activation process, from sample preparation, through the use of standard samples and the actual process of irradiation, to spectrum analysis. The authors also acknowledge the importance of the statistical interpretation of the analytical results by their relatively lengthy explanation of the clustering

program used.

Pottery provenience studies have become increasingly important, and more common, in Near Eastern archaeological studies. Determination of clay sources and probable sites of manufacture of ceramics aid in understanding trade networks for a number of chronological and geographical settings in the ancient Near East. Specific problems formulated for these studies are usually geared toward confirming or supporting, and supplementing the more conventional archaeologically derived information on social and economic behavior. For example, pottery assigned to the Persian period at the site of Tell el-Hesi in Israel was compared to pottery and clays from the surrounding area in an effort to determine patterns of local manufacture and trade (Brooks, et.al. 1974). The background for this chemical comparison, using NAA, lay in archaeologically and biblically-derived information which pointed to the possibility of a trade relationship involving Hesi and the political entities of Judah, Ashdod and Gaza. The authors relied on modern potters to locate clay sources of the area . The ethnographic - informant approach to locating clay sources has been successfully used (Rye 1981; Rice 1978), and can be timesaving for the archaeologist interested in pottery provenience studies.

Evidence of local production of pottery provided the impetus for neutron activation analysis of Early Bronze Age pottery from Central Greece. Kiln wasters were found on-site

at Lake Vouliagmeni. A total of one hundred pottery samples was analyzed, of different time periods (Attas, et.al. 1977:33); and raw clay and mudbrick samples were also analyzed. The authors based their analytical approach on the work of Perlman and Asaro (1969) and Abascal-M. et.al. (1974). They used the standard pottery analyzed by Perlman and Asaro as their elemental standards. Fifteen elements were found to be useful for their comparisons (Attas, et al.1977:36). The distinct chemical groups of ceramics were correlated with three separate time periods.

Neutron activation analysis was employed for Near Eastern Middle Bronze Age period ceramics to detect specific trace elements in the pottery types to compare to the chemical composition of other ceramic samples (Kaplan 1982:134-135). The analysis confirmed that there were probably two main manufacturing centers of Tell el Yahudiyeh ware, one in Egypt and one in the Levant, a conclusion which improved understanding of the political and economic situation of the region (Ibid.:141).

The last neutron activation case example considered here involves Guatemalan pottery-clay source provenience studies (Rice 1978). The effects of pottery manufacture processes on raw clays and the degree of variation within a clay deposit was the subject of Rice's report. She looked at the effects of temper addition and fine fractioning in clay processing, and the effect of firing on clays. She also observed chemical variation within a clay source.

The situations were all created experimentally (Ibid.:522) except for the clay deposit variability. She concluded that the addition of temper to clay can cause variability in element proportions of pottery. She noted that the effects of temper addition should be further investigated (Ibid.:534, 538). She also concluded that the effects of firing temperature for chemical comparison of clay and pottery are probably insignificant. In addition, analytical results indicated that fine fractioning of clay probably results in "statistically insignificant" variation (Ibid.:535). These conclusions are significant contributions to an understanding of how the results of NAA may be interpreted with respect to cultural behavior and natural influence.

Rice examined assumptions about the appropriateness of the analytical approach for the question of provenience, and assumptions about the anthropological approach to interpretation of behavior. Her conclusions about these assumptions were considered by the author before INAA was chosen as the technique. Rice stated that the methodological assumptions have been adequately explored, but not the behavioral assumptions used to interpret the results of the methodology (Rice 1978:513). There are still uncertainties of how pottery manufacture processes may affect the physiochemical results which will be used as a basis for the behavioral interpretations.

The questions related to this uncertainty are a) does the pottery manufacture process entail behavior which can obscure a direct correlation between suspected clay sources and pottery; and b) if there are indeed behavioral processes in response to the demands of pottery production which might influence a direct clay-pottery correlation, can these processes be detected by the nature of their influence on the pottery composition? We need to know what chemical-interactive processes might cause pottery to deviate from a known clay (and possible source) composition, and how these changes may be manifested as chemical variations. For further discussion of this problem, and its resolution for the purposes of the BFI study, see page 103.

Summary

The literature on NAA and clay-pottery provenience studies provided background necessary to formulate an approach to the Black Fox Island clay-pottery provenience study. Through these readings, and consultation with persons knowledgable in related analytical studies, it became obvious that instrumental neutron activation was the technique which would be employed for the BFI study. In addition to providing information on implementing the technique, the literature survey of provenience studies provided insights on the interpretive requirements and assumptions applicable to the BFI study. Foremostly, the archaeological context must provide the interpretive

component for the chemical analytical interpretation. In addition, each pottery-clay provenience study requires its own approach to statistical interpretation necessitated by the nature of the sample population. Of especial significance to the objective of source provenience detection is the conclusion that NAA can be applied for a direct comparison of clays and pottery without undue worries about how the clay preparation would have influenced the chemical comparative results.

INAA - Procedure and results

A decision on the appropriate chemical-analytical technique to use for comparing raw clay with pottery requires an evaluation of the question: Will the analytical results answer the questions asked? The working hypothesis states that the pottery of Black Fox Island, either of site GfPa-32 or site GfPa-41, was made of one of the raw clay source(s) on the east shore of the island. The literature on source provenience studies indicates that chemical analysis can be used for direct comparison of these two substances (see above). Chemical comparison should detect a pattern or fingerprint of elements or compounds within the clays and the pottery which may confirm or reject a common geological origin for the samples compared.

Rankin (1971) briefly discusses the use of analytical chemistry techniques in the characterization of modern ceramics. For each individual case there are several factors

which should be considered in deciding upon a method of analysis (Rankin 1971:30). These factors were considered in choosing the method to use for the Black Fox Island pottery and clay tests.

Neutron activation analysis was attractive as a means to investigate the Black Fox Island source clay provenience problem. It promised precise qualitative and quantitative data for a direct comparison between samples of two solids (clay and pottery). A distinctive fingerprint of each sample results from the trace element analysis. The precision with which elements can be detected is better than 10%; usually 2% to 5% accuracy is achieved, which is comparable to or better than other chemical analyses (Tite 1972:259). The method allows many elements, up to 35 to 40, to be routinely analyzed. Its multi-elemental detection capability is superior to that of other chemical methods (Ibid.). The analysis can be carried out non-destructively; although in the BFI analysis, some non-diagnostic, tiny sherds were pulverized. Preparation of samples is minimal, requiring few steps and little handling, so the risk of cross contamination between samples is decreased.

Of secondary importance in the decision for INAA, the facility was available on campus. A SLOWPOKE II Nuclear Reactor Facility is located at the University of Alberta. The author was readily offered its services and technical aid for the project. Dr. F. Longstaffe, a professor of clay mineralogy in the Geology Department, University of Alberta,

was consulted as to the suitability of INAA for the project. He recommended the technique as more suitable than X-ray diffraction analysis for comparison of raw clay with pottery (fired clay), due to the possibility that the clay mineral structure, which is detected during X-ray diffraction, would have been destroyed or altered during firing, leaving no basis of comparison between the raw clay and the pottery.

Selection and preparation of samples to use for INAA

During the Black Fox Island project, raw clay was collected from three locations of Black Fox Island's east shore. Clay 1 was known to a local resident who brought it to the author's attention (T. Maccagno, pers. communication 1982). Clays 2 and 3 were found through survey of the east shore. The beach areas from which the clays were collected were low-lying, cobble-covered and with sparse vegetation. The beaches had been periodically flooded throughout the years. The shoreline was inundated in 1975, during the season of E.J. McCullough's survey (T. Maccagno, personal communication). The clay deposits were noticable as locations where the beach mud (beneath the cobble cover) was stickier, or more gumbo-like, than usual. Each sample was collected through shovel probe from at least one foot (30 cm) below the beach surface, and placed in a plastic bag.

A feature on site GfPa-32 yielded a lens which appeared to be dried clay. The deposit was extremely hard and difficult to dig through. When dislodged from the feature

area, it was fine and silt-like. This sample, called Clay 4, was tested to see if it was a deposit of clay from a source on the beach, and/or if Pot 1 had been made of it. Clay 4 required no preparation other than encapsulation. Each clay sample was measured to an approximate mass of 120 mg.

Each clay had different properties and characteristics which were obvious in the collection stage, in subsequent experimental modelling, and in preparation of sample tiles. The clays were likely of lacustrine formation. They all contained organic matter, as evidenced by the color (Goffer 1980:115) and suggested by their physical association (Shepard 1976:19), and by bits of what appears to be organic matter visible in the thin sections. According to Shepard, these dark-colored, organic clays might fire to a brown, grey or black color in pottery (Shepard 1976:17), a range which approximates the colors of the GfPa-32 vessel and the GfPa-41 sherd. However, it is noted that raw clay color is not necessarily a reliable indicator of fired clay (pottery) color (Ibid.:16).

The deposits are fairly close to the sites where pottery was found, and so it seemed feasible that they were collected and used prehistorically (see Rye 1981:12 regarding the "principle of least effort" and pottery raw materials collection). The clays were tested for their suitability for pottery manufacture by modelling and firing small vessels made from each of the clays with the addition of varying amounts or proportions of temper. The experiments

indicated that the clays were suitable.

Each clay was easily modelled, although there were varying degrees of plasticity. Clay 1, the southernmost clay, was collected from the beach; and was, therefore, the clay closest to site GfPa-32 and site GfPa-41. It was dark brown in color in its unfired state. Its workability was good, although it was least plastic of the three clays collected. Clay 2 was collected north of Clay 1. It was very plastic and easily worked. It was sandier in texture than Clays 1 and 3. Clay 3 was very plastic and sticky, more so than any other samples. Organic material was visible in it.

The experimentation with the clays was a necessary preliminary step to further testing of the clays with the more elaborate and expensive techniques of INAA and thin-section analysis. The fact that the small pots could be made from the clay and that they survived firing was an indication of potential use by prehistoric potters.

Sherds from GfPa-32 Pot 1, and a sherd from GfPa-41 Pot 2 were selected for INAA. The sherds selected from the GfPa-32 assemblage were considered to be non-essential for reconstruction of Pot 1 or further analysis. They were considered to be representative of Pot 1's material construction, and also of its vertical and horizontal distribution on site. The sherd used to test the GfPa-41 vessel (Pot 2) was the least diagnostic of the three sherds collected from a test pit. The sherds were prepared for irradiation by grinding them manually in a glass mortar and

pestle. Inclusions larger than 0.07 mm were removed by screening the ground pottery. It was decided that most inclusions smaller than 0.07 mm were probably a natural occurrence in the clay used to make the pottery. Because the pottery was to be compared to raw untempered clay from the beach, the screening was an attempt to bring the two media to as similar a state as possible. The resultant fine powder was weighed to a mass of ca. 120 mg. Each aliquot was placed into plastic vials which were heat-sealed.

The raw clays were formed into tiles approximately 6.0 cm^2. These tiles were labelled according to source location, and fired in a small electric kiln. The maximum temperature attained was 925° C, over a period of four and half hours. The temperature was purposely kept below 1000° C so as not to exceed the maximum temperature attainable in open hearth, low temperature firing (Rye 1981:25,98; Shepard 1976:83). The maximum temperature attained was restricted because it was thought important to control for chemical reactions of mineral inclusions and the clay minerals which occur at certain temperatures(Shepard 1976:19-24; Goffer 1980:114-115). Rice (1978:535) found that firing temperatures between 700° C and 850° C caused statistically insignificant chemical change to clay.

The tiles were then ground to a fine powder in an agate swing mill. The powder was prepared for irradiation in the nuclear site by encapsulating it in polyethelene vials.

A factor in sample preparation is related to pottery technology and the analyst's knowledge of how the clay was likely prepared for ceramics manufacture. Visual examination of the Black Fox island pottery indicated that granitic rock temper had been added to the clay. Addition of crushed granite in Plains pottery manufacture is also documented ethnographically. In preparing the samples for INAA, with the intention of comparing their chemical-elemental content, the question was whether to delete the suspected temper inclusions from the pottery, or to add temper in an attempt to duplicate the prehistoric tempering practice.

Hanna (1982:150) argues against attempting to delete the temper from the potsherds. She cites three reasons not to remove the temper: 1) because there is no absolute way of knowing which inclusions were added and which were natural; 2) because it is not feasible to remove all the aplastics; 3) because it is not possible to remove equivalent proportions from each sample. These objections were waived in the Black Fox Island analysis because it was strongly suspected that the temper present in the pottery would cause a deviation in the analytical results which would be detrimental to the comparison of the pottery samples with the potential clay sources. The author feels that Hanna is correct in not removing temper when doing pottery to pottery comparisons. The author contends that it is necessary to remove suspected tempering inclusions from pottery when comparing it to clay.

When Rice (1978) conducted INAA on clay and pottery samples from the Valley of Guatemala she added volcanic ash to some of the raw clay samples to see how the addition of temper would affect the chemical analysis. She used raw clay without volcanic ash or other inclusions as a control group. She concluded that it was difficult to duplicate the tempering patterns of the prehistoric potters (Rice 1978:534). The results of Rice's comparison of tempered (ash) clay with untempered clay showed that the addition of temper to the clay resulted in a modification of the element quantities (Ibid.: 528-532; 538). Rice stated that "variations in trace constituents caused by temper addition may form a significant part of variability determined from characterization studies of pottery, but may be deranging factors in provenience studies by confounding the relationship of a clay source and pottery made of that clay."

The author interprets this conclusion to mean that in comparing pottery to pottery the trace element variation caused by temper may be significant in differentiating the samples, but for clay-pottery comparisons the addition of temper is misleading. Rice's observations were used to confirm the decision to separate the most obvious inclusions from the BFI pottery rather than try to duplicate the tempering pattern . She further states that if the chemical properties of the temper are known, they can be taken into consideration in interpretation and comparison of the

results.

A second issue in sample preparation is whether or not the raw clay samples should be fired before irradiation. Hammond, et al.(1976) dried but did not fire the clays they analyzed. Hanna (1982) dried raw clay in an oven to remove the moisture before grinding it to powder. Abascal-M., et al. (1974) dried clay in an oven at 65° - 70° C. Attas, et al. (1977) did fire clay samples at 700° C for one hour in an electric kiln. They concluded, however, that low temperature firing probably had "little effect on the ceramic composition," (Attas, et al. 1977:41). Freeth (1967) reported no significant change in the relative concentrations of major oxides when a sample of clay was formed into a pot and fired at 800°C for four days. He recommended that when clay is to be compared to pottery, all samples should be heated to 700°C before analysis (Freeth 1967:109). If an element is known to be highly volatile, it should not be used for comparative purposes especially when the sample clay is fired (Rye 1981:49). It seems to be optional whether to fire or not to fire raw clay samples for clay-pottery comparison.

Irradiation and counting of samples

Two sequences of irradiation were employed to analyze the samples. An initial, short irradiation and counting episode was employed to arrive at preliminary results involving the shorter-lived (short half-lives) isotopes, to

give an idea of how the method was going to work for the clay-pottery comparison. A longer irradiation and counting period was employed to detect some of the longer-lived isotopes, thus increasing the number of elements to be used for comparison.

Discussion of irradiation and counting procedure

The preceding discussion of techniques of chemical analysis introduced the reader to the principles of INAA. For more detail on the physics theory related to INAA, the reader is referred to a brief introduction to the technique in Duke (1983:4-8). A brief discussion related to the mechanics of irradiation and counting using the SLOWPOKE reactor and associated counting equipment is appropriate here.

The SLOWPOKE nuclear reactor used at the University of Alberta is described in Duke (1983) and in Appendix 3 of this paper. The reactor provides the neutron flux which is used to irradiate samples. The samples are automatically transported into an irradiation site within the reactor, where they are submitted to the neutron flux, which has been set to an "equal, homogeneous" level (Duke 1983:12). The stability and reproducibility of this flux eliminates the need to irradiate the sample along with a standard sample of known quantity. After the sample has been exposed to the neutron flux, producing radioisotopes of elements within the sample, it is brought out of the site. It is allowed to

decay for a specified time period. The time period of decay varies with the half-life of the elements to be detected. Samples having radioisotopes with short half-lives must be counted shortly after irradiation, if the elements are to be identified accurately or even identified at all. To reduce background noise a sample is purposely left for a period of time to allow the short-lived radioisotopes to decay, permitting a clearer reading of long-lived radioisotopes.

The decaying radioisotopes, or in the case of neutron activation, radionuclides, emit gamma-rays which have particular energy levels used to identify specific elements. In order to record the gamma peaks symptomatic of the energy level of the decaying radionuclides, the irradiated sample is subjected to a counting process using a detector/analyzer combination. The University of Alberta SLOWPOKE Reactor facility has an Ortec 80 cm^3 active volume Win^{15} coaxial Ge(Li) gamma ray detector. The detector is linked to a Nuclear Data 660 multichannel analyzer. The gamma ray energy emmitted by radionuclides is translated into gamma spectra which are read on the analyzer screen. Figure 7 is a representation of gamma spectrum of Pot 1(GfPa-32). Gamma photopeak intensity is measured by a determination of photopeak area. The correct geometric distance can be calculated and controlled for, as it was in the BFI sample analysis. Once the photopeak area is calculated, the element which produced the radioisotope can be identified and quantified.

Short irradiation procedure

Samples of the two pottery vessels, 12 of Pot 1 (GfPa-32) and two of Pot 2 (GfPa-41), and two samples of each of the raw clays were irradiated for four minutes in site 1 of the SLOWPOKE reactor at a flux of 1.0 X 10^{11}n cm^{-2} s^{-1}. After they were irradiated, they were allowed to decay for a period of thirty minutes. All samples were then counted for a period of 600s live time. The Ortec 80 cm^3Ge(Li) (germanium lithium) detector, linked to the Nuclear Data 660 multichannel analyzer, were used to count the samples. The resultant spectral data was immediately recorded on computer disc where it was processed and printed out for examination.

The elements detected after the short irradiation and counting period included U, Dy, Sm, Eu, Ba, Na, K, Mn_1, Mn_4, Na(1) and Ca. These elements were selected to represent the compositions of the samples. (See Table 2 for a key to the abbreviations of the elements used for this analysis and their half-lives). Some of these elements were again detected and counted during the long irradiation and counting.

Long irradiation and counting of samples

All samples of Pot 1, Pot 2 and Clays 1, 2 and 3 which were irradiated for the short term analysis were re-irradiated for two hours at a flux of 1 X 10^{12} n cm^{-2} s^{-1}. In addition, a new clay sample, Clay 4, from a feature

on GfPa-32, was irradiated at this time for comparison with the other clay and pottery samples. The samples were then allowed to decay for six days, and were counted for 3600s on the Ge(Li) detector. A number of elements were detected. The same samples were allowed to decay for a further 15 days, to total a 21 day decay period, after which they were counted for 10,000 seconds. Twenty-two elements were chosen for comparative purposes from the results of the longer term irradiation and counting. A decision was made to increase the sample sizes of the clays and Pot 2 for greater statistical accuracy. The original 12 samples of Pot 1, and a total of six samples of Pot 2, three samples for each of Clays 1,2 and 3, and six samples of Clay 4, were irradiated for two hours at 1 X 10^{12} cm^{-2} s^{-1}. They were counted both after six days and after 21 days. The results of these additional irradiations were averaged into the results obtained from the previous short-term irradiation. The elements selected for statistical analysis from those detected in the long term irradiation were Sm, Eu, U, Th, Ta, Sc, Co, Sb, Fe, Na, As.

Results of INAA of pottery and clays

Irradiation and counting of the samples resulted in detection and quantification of a number of elements. In most cases, the quantity of each element is expressed in parts per million (ppm) with a standard deviation. These element quantifications are the basis for comparison of the

pottery and clay samples. The raw numerical data of the element quantifications can be used for comparisons on a visual checking basis.

Not all elements are useful for comparison. Some element quantities appear to vary erratically rather than significantly, for there is little coherence in their variation. Usually, therefore, a subset of the elements detected is selected for use in the comparisons.

Visual determination of chemical similarity is a preliminary step in creating trial pottery groups (Perlman and Asaro 1969:31). It is also the preliminary step in confirming homogeneity within existant groups such as Clay 1, Clay 2, Pot 1 and Pot 2 in the BFI analysis. Before the INAA results were subjected to statistical analysis, they were visually examined for any indications of clay-pottery similarities. Several preliminary conclusions were reached as a result of the non-statistical, visual comparisons of element quantities.

Non-statistical comparisons

Table 3 lists element quantities for Pot 1 and Clays 1,2 and 3. Twenty-two elements were used in the comparison of Pot 1 (GfPa-32) with the three beach clay samples. The results displayed in Table 3 were used to arrive at a preliminary conclusion that Pot 1 is not similar to either Clay 1, Clay 2 or Clay 3. The mean values of Sm, Eu, Lu, U, Ta, Fe, Na and As vary by greater than three standard

deviations between the clay samples and the pottery samples. This variation is a strong indication that Pot 1 differs significantly from the clay.

Another preliminary conclusion of the non-statistical comparison is that the samples of Pot 1 form an homogenous group; the samples of Pot 2 are homogenous; and each of the Clay 1, Clay 2, Clay 3 and Clay 4 samples are homogenous within themselves. It is important for the analysis that each sample forms a group distinct from the other samples. The results of the 21-day count indicated that each of the three clay samples differ from one another, yet each is more similar to the other clay samples than to either of the two pottery samples. In addition, the 21-day count results indicated that Pot 2 (GfPa-41) differs in elemental composition from Pot 1.

The conclusions indicating homogeneity were based on visual comparison at a time in the analysis when the sample population size for each of the clays and pots was too small for rigorous statistical comparisons. The relationships of homogeneity are further demonstrated in Figure 8.

Statistical analysis of INAA results

A statistical analysis of the INAA results necessitated formulation of an approach appropriate to the comparisons. The primary consideration was, what were the comparisons intended to indicate? Generally, a comparison is intended to show similarity or dissimilarity between two or more items

or populations. In the Black Fox Island pottery-clay comparison, the INAA results were expected to show whether or not Pot 1 and/or Pot 2 were similar (and potentially the same) or dissimilar to the raw clays located on the island. A statement to express this main objective of the analysis was advanced as a working hypothesis: The pottery of Black Fox Island (Pot 1 and/or Pot 2) was manufactured of clay from one of three potential sources sampled on the island (Clay 1, Clay 2 or Clay 3). The analysis had three secondary objectives: to assess the similarity or difference between Clay 4 (GfPa-32 feature) and Pot 1 and Pot 2; and to compare Clay 4 to Clays 1,2,3; and to assess the similarity or difference between Pot 1 and Pot 2.

Statistical methods

The statistical analysis of the INAA results was conducted using the Michigan Interactive Data Analysis System (MIDAS) available on the University of Alberta mainframe computer. For the statistical comparisons, the sample size (n) for Pot 1 is 12; for Pot 2, n=6; for Clay 1, n=3; for Clay 2, n=3; for Clay 3, n=3; and for Clay 4, n=6. Eleven elements (Sm, Eu, U, Th, Ta, Sc, Co, Sb, Fe, Na, As) were selected to use in the comparisons.

Cluster analysis

The scatterplot is a visual representation of clustering of samples, to show distance between samples,

indicating closeness/similarity, or apartness/dissimilarity (Attas, et al. 1977:38). A scatterplot representation (Figure 8) comparing the variation of Sb to As was the first statistically-derived indication confirming the conclusions of the visual comparisons of the data. Antimony (Sb) and arsenic (As) were used because their values appeared to vary with a good degree of coherence. The scatterplot also provides a more specific indication of the relationships between the samples. As stated by Hammond, et al. (1976:164), "Common membership of a cluster implies a high degree of similarity in trace-element composition: the tighter the clustering and shorter the distance between samples, the greater the chance they emanate from the same original clay source."

The scatterplot shows that Pot 1 is separate from, and therefore different than, Pot 2 and Clays 1,2,3,4. Pot 2 is different than Clays 1,2,and 3 in addition to differing from Pot 1. Pot 2 may have a relationship with Clay 4, as indicated in the scatterplot. Clay 1 is separate from and different than all other samples but closer to the other clay samples than to the pottery samples. Clays 2, 3 and 4 are obviously related to one another, for they group closely together.

Analysis of variance and Student's t-test

Although the samples were increased for the statistical analysis the sample size was still considered small. A

decision was made to use the analysis of variance F-test and the Student's t-test because they are particularly suited to drawing inferences from small sample populations. The F distribution test is used to compare two or more groups (Mendenhall/Reinmuth 1978: 305). The Student's t-test is used to compare two groups or samples at a time; for example, Pot 1 and Pot 2. It is suggested for use when the sample size is less than 30 (Ibid.:282). In order to interpret the results of these two statistical tests, a null hypothesis and an alternative hypothesis were established (Ibid.:283, 307). The null hypothesis (H_o) stated that the two samples compared were indistinguishable from one another, implying that they may be similar or the same. The alternative hypothesis (H_1) stated that two samples compared were not equal to, or different from, one another.

The objective of the statistical analysis using the quantitative INAA results was to determine the similarity or difference between two samples. First, the analysis of variance (F-test) was examined for significance. Where the F-test significance was greater than 0.10, the result indicated that the variances were equal, within a 90% confidence level. The Student's t-test significance was then evaluated to see if the means were equal. Where the Student's t-test significance was less than 0.010, the null hypothesis (H_o) was rejected and the alternative hypothesis (H_1) was accepted. In certain situations, the F-test significance or the Student's t-test significance rendered

some cases ineligible (P). Table 4 presents some examples of the statistical comparisons between the INAA results for the samples.

To summarize the results of the statistical comparisons: INAA did not reveal a correspondence or similarity between Clays 1, 2 ,3 or 4 and Pot 1 or Pot 2. The statistical analysis yielded inconclusive results for the Pot 2 and Clay 4 comparison. The null hypothesis (H_o) was accepted for the Clay 2 and Clay 4 comparison, indicating sameness or similarity.

Interpretation of INAA

Data related to the typological assignment of Pot 1 has been presented. Now the results of the INAA must be interpreted for their significance in relation to the prehistoric processes which may have occurred on Black Fox Island.

The results of the INAA rejects the hypothesis of manufacture of Pot 1 from Black Fox Island clay (Hypothesis 1). As stated above, the statistical comparison of the INAA results indicates that none of the island's clays 1,2,3 or 4 correlate with either Pot 1 or Pot 2 on the basis of chemical composition. The mineralogical data (see below) shows what minerals are present, and of what sizes and quantities. Comparisons of the mineralogy of the clay and pottery samples indicate that, of the clays, Clay 2 is most similar to the pottery samples. Quartz and feldspar minerals

predominate in all the clay and pottery samples.

The test implications of the working hypothesis, Hypothesis 1, requires that clay be present on Black Fox Island, which it was; and that the clay chemical composition be compared with the pottery chemical composition. In order to prove the hypothesis, the clay found on the island would have to be, without doubt, chemically and mineralogically the same as the pottery. This test implication was not confirmed, and so it must be stated that Pot 1 of GfPa-32 was not manufactured of clay taken from the three known locales on Black Fox Island.

B. Part Two: The Mineralogical Analysis of Pot 1

The general objectives of petrographic analysis in pottery studies

There are three main objectives which could be fulfilled by petrographic analysis of prehistoric pottery and fired clay samples. One objective is to study the technology applied to the pottery, as demonstrated by the clay and the mineral temper. The quantity and the type of mineral inclusions, and their shapes and sizes, the presence of organic inclusions, the orientation of particles in the clay matrix; and other observable physical characteristics of the pottery matrix provide information on technological practices.

A second objective is to identify the source area of the mineral inclusions, indicating the provenience of origin of a ceramic item. The correlation of mineral types with distinctive geologic formations and processes of an area may reveal where tempering material was obtained; or where a clay, with naturally occurring minerals, was obtained. This objective may not be realized in a region of geologic homogeneity.

A third objective of petrographic analysis is to provide data for comparison of one vessel with another. An examination and description of the fabric of a ceramic item can provide a distinctive means of comparison with another vessel or item, reflecting differences in the types of

materials used, quantity of materials used, differences in manufacturing (molding and firing) technique, and other factors. Although ceramics can often be compared based on stylistic or other physical attributes of a vessel or sherd (surface finish, firing core, thickness, porosity, etc.) a microscopic examination of the pottery fabric may reveal additional, and sometimes more objective, information.

In the Black Fox Island study, the petrographic/ mineralogical analysis had all three objectives. The major objective in the use of petrographic analysis with Black Fox Island prehistoric ceramics and fired local clay samples was a limited provenience study. The temper of Pot 1 was compared to the descriptions of temper from other northern plains vessels (Bower 1973). In addition, knowledge of which materials were selected to create a cultural product is itself an insight into technologically-related behavior patterns. In this section, case examples of pottery petrographic studies will illustrate the utility of the technique of petrographic analysis for pottery provenience, and comparative and technological studies. A short discussion of the principles and method of petrographic analysis will precede the case examples of petrographic study.

Method of petrographic analysis

Petrographic analysis of ceramics samples is adapted from microscopic analysis of geological rock specimens. When

studying pottery, mineral identifications may often be made using the naked eye or a magnifying glass. In some cases, minerals may be recognized using a binocular microscope. These approaches result in identification of some minerals or sand. In cases where a more specific and complete identification of mineral content is required (quantity, exact mineral type such as feldspar, quartz) the petrographic microscope must be used (Shepard 1976:157).

The petrographic microscope and thin-sections

The petrographic microscope utilizes the properties of light and of mineral crystal structure so that exact identifications of minerals in thin-section can be made. The petrographic microscope is described in great detail in Kerr (1959:11-37) and Phillips (1971:17-46). The purpose of thin-sectioning is to prepare a sample of pottery so that light can pass through the minerals imbedded in the pottery matrix, allowing the minerals to be identified. The standard thickness for pottery thin sections is 0.03 mm, which is thin enough to allow light to be transmitted through minerals normally found in pottery. The preparation of rock thin sections, described in Kerr (1959:4-9) and Phillips (1971:232-236), has been adapted to pottery thin-sectioning. Thin-sectioning of pottery samples is described in greater detail in Porter (1964a), Hanna (1982:175-177), and Bower (1973:78-81).

Petrographic studies and behavioral inferences

The ultimate aim of petrographic analysis is to look at behavior associated with pottery production. Firstly, as in the Black Fox Island analysis, clay source provenience may be sought. The choice of clay, with its natural mineral inclusions, was a conscious decision on the part of the potter, although possibly constrained by source limitations and other factors.

Another behavior, the collection of minerals for tempering, was a conscious decision, as was the practice of separating out unwanted minerals (Brizinski and Buchanan 1977:85-86;163). The results of these decisions of clay and tempering materials collection are observable through petrographic analysis.

The archaeologist can then attempt to recognize the knowledge and motivation behind the selection of the manufacturing materials. Was it calculated on the basis of personal experience with, or acquired knowledge (tradition) of how the materials will react in the manufacturing process? Was it experimentation, or necessity because no other materials were at hand? Once the identity of the materials is known, the archaeologist can consider what their properties are and why they were perceived as suitable for pottery manufacture. This analysis can lead to conclusions or speculation on the sophistication of the pottery technology.

Identification of shared behavior in pottery manufacture process is effected by noting similarities of materials used and the manner in which they were used. The petrographic microscope can indicate that the materials of comparative samples were collected from the same sources (clay and temper), that they were prepared identically, that the same quantities were used, and that they were distributed in the vessel fabric in the same manner (temper). Along with noting similarity of manufacture process and materials, similarity of cultural origin may be inferred.

Case examples

Petrographic analysis used in the study of pottery materials and construction has a fairly long history and widespread and diverse application (Bower 1973:10-21; Hanna 1982:37-45). A familiarity with the literature is again a required means to understand the technique and the results and interpretations obtainable. Some petrographic studies of relevance to the Black Fox Island pottery analysis are:

1) In a study of ethnographic pottery samples from Quinua, Ayacucho, Peru, by Arnold (1972), thin-section analysis complemented X-ray diffraction analysis. A clay with a high incidence of natural minerals was used 'as is' by local potters, and was recognized by the potters on the basis of the mica present. This behavior is difficult to detect archaeologically, even with petrographic analysis. A

non-naturally tempered clay had very little mica. The main value of Arnold's article is to recognize that alternate and difficult-to-detect behaviors may be responsible for the presence of certain minerals in clay.

2) Sudanese Neolithic ceramics were characterized mineralogically using petrographic and X-ray diffraction analyses (Hays and Hassan 1974). Ceramics from a specific geographic locale and temporal horizon were made locally, based on pottery mineral correlation with the minerals from known geologic formations in the area. They also determined that although the same materials were used to make Khartoum style ceramics, they were probably used in different ways by different groups (Hays and Hassan 1974:78). This analysis shows that petrographic study is effective for source provenience studies in the case where the local geology is known. It also offers evidence of a technological practice which may have been dictated by cultural tradition or individual preference rather than by the raw material characteristics.

3) An acknowledged "classic" study in petrographic analysis of North American ceramics is A.O. Shepard's test involving Rio Grande Glaze-Paint pottery from the Pecos site in the Southwest U.S.(Shepard 1965). The ware has a recognized, stylistically traceable developmental sequence defined by M.A. Kidder and A.V. Kidder (Shepard 1965:66). Shepard examined a large number of thin-sections using a binocular microscope to identify major temper classes and

paste differences. Local clays were collected and mineral geology of the region was researched (Ibid.:68). Two significant observations of the petrographic examination are that there are tempering variations between the samples and also that some of the temper is non-local, implying that those pots containing it are non-local (Ibid.). Thus the Pecos Glaze-Paint ware petrographic study caused the local culture history to be reinterpreted (Ibid.:71).

Further studies were initiated, using pottery from sites of the entire Rio Grande Valley region. Shepard used a binocular microscope for close to 15,000 sherds from 170 sites. The result is an extensive contribution to the study of pottery of the Southwest, especially as Shepard correlated the minerals observed in thin section with the geologic regions.

4) In a petrographic analysis of Late Woodland pottery from the Sperry site in Missouri, N.O. O'Malley (1981) concluded that temper can be inaccurately identified through megascopic examination but can be accurately identified with a microscope. A by-product of thin-section mineralogical analysis is the fact that the pottery fabric can be observed for features indicating construction methods, such as orientation of particles. Some of these features are noted in O'Malley (1981:245). O'Malley's interpretations of "behavioral modes" to explain the physical properties of the sherd thin-sections are of particular interest (Ibid.:248). One of O'Malley's research concerns was with differentiating

minerals culturally added from those minerals which comprised natural inclusions of the clay. Her inference, based on her geological knowledge and observations, was that clay containing a certain size distribution and type of mineral was used, and other tempering materials were added to it.

5) The primary means of mineralogical analysis in Brizinski and Buchanan's (1977) study of ceramic tradition in the Michipicoten area of Ontario was X-ray diffraction, but some preliminary mineral identifications were made using thin-sections. Quartz and feldspars were identified. The feldspars appeared to have been altered by firing, according to the authors (Brizinski and Buchanan 1977:47). The minerals identified in thin-section also appeared in the X-ray diffraction analysis.

6) M. Hanna (1982) used thin-sections for a qualitative analysis of minerals in pottery. Her petrographic analysis was supplemented by X-ray diffraction analysis. She examined Duck Bay ware and clay samples from Manitoba. She found that feldspar is the mineral of greatest relative proportion; and that trace minerals biotite, amphibole, garnet, pyroxene, olivine and chlorite are present. Feldspar and quartz are the components of the clay samples. Hanna suggests that "feldspar was the desired mineral tempering material." (Hanna 1982:179).

Analysis of the mineral content was accompanied by observations of a "bimodal distribution" in the pottery,

with most mineral inclusions either greater than 1 mm² or less than 1/16 mm². The inclusions less than 1/4 mm² were angular. In the clays analyzed, mineral inclusions were all less than 1/4 mm², and rounded or subrounded. These results suggest that the inclusions over 1/4 mm² are temper, whereas those less than 1/4 mm² are a natural occurrence in the clay. She further speculates on the behavior pattern suggested by the distribution of mineral inclusions (Ibid.:182). The mineral characteristics of the pottery are unlike those in any one clay examined, but could be explained as a combination of two clays' mineral components. Hanna suggests that two clays may have been mixed to produce the ceramics at one site.

7) The last petrographic study to be mentioned here is the most relevant to the Black Fox Island study, both in geographic location and in problem orientation. Carolyn Bower (1973) studied the mineralogy of ceramics from the Northwestern Plains. Specifically, she looked at pottery from Alberta, some identified as SBW ceramics and Cluny ceramics (Byrne 1973), and cord-marked and fabric-impressed ceramics from Saskatchewan, under the petrographic microscope. Her ultimate aim was to discern the relationship between raw materials, pottery technology, and the function of the product within the society. She approaches her objective by suggesting "that there was stimulus for continued production of pottery by nomads", asking specific questions such as a) What was the role of pottery in the

society, was it made locally, and what materials were used; and b) Is there evidence for materials selection both contemporaneously and through time at a site (Bower 1973:7-8). Petrographic analysis aids in ascertaining source provenience of materials and characteristics indicating continuity. Bower's problem orientation reflects the kinds of answers which petrographic analysis can give. She recognizes that certain data on physical properties may indicate behavior patterns (Ibid.:21).

Bower postulates that nomadic potters, because of limited time for and interest in ceramics, were eminently conservative in their pottery technological behavior (Ibid.:55). One particular aspect of Bower's suggestions focuses on the granitic inclusions which occurred in sherds from all Albertan sites, and whether or not their consistent occurrence constitutes a technological tradition as defined by Shepard (1976:320). This suggestion will be considered. There were some indications of a granitic inclusions trend in Saskatchewan sherds, also (Ibid.:60).

Bower's megascopic and microscopic descriptions of each sherd thin-sectioned are useful to the Black Fox Island study. They provide a means of comparison based on material/physical qualities rather than less objective comparison of appearance (style, decoration) and inclusions observable by eye. Bower's thin-sections, on loan from the Department of Archaeology, University of Calgary, were examined, and some were visually compared to the BFI

thin-sections. Her own descriptions of the thin-sections were also compared to the data generated for the BFI samples. (See below for results of these comparisons.

Mineralogical analysis of Black Fox Island specimens

Mineralogical analyses were conducted of thin-sections from Pot 1 (GfPa-32) and Pot 2 (GfPa-41), and from Clay 1, Clay 2 and Clay 3. The analysis had two main objectives. The first was to identify and characterize minerals in each of the clay and pottery samples in order to provide an objective descriptive basis for comparison of all the samples with one another. The mineralogy of each of the specimens was described in terms of type of mineral, size of mineral and shape of mineral. A relative density or quantity was also noted in most cases. A precise quantitative measure of the minerals was not made. The characterization of the mineral components of each sample allowed the samples to be differentiated from or equated with one another. This mineralogical comparison supplemented the results of the chemical (INAA) analysis. The mineralogical study was not necessarily expected to support the INAA results (Hanna 1982:66), but there was a possibility that such confirmation would occur.

As a second objective, the mineralogical analysis was also intended to provide data on pottery manufacture behavior related to Pot 1. Certain mineral inclusions detected in the vessels were suspected to be temper (Rye

1981:52). These suspected temper inclusions were studied to determine the source of the temper, how it may have been obtained and processed, what factors may have determined how much and what kinds of minerals were added, and how the temper contributed to ceramic performance in the manufacturing and functional stages.

Procedure and results

Thin-sections were made of Pot 1 and Pot 2 and of the tiles manufactured of the three island source clay samples. Clay 4 was not examined in the mineralogical analysis. The thin-sections were mounted on glass slides and examined under a petrographic microscope. The minerals in the pottery and clay samples were identified and described by D. Schnurrenberger, Dept. of Geology, University of Alberta. The objective of the thin-section analysis was to obtain specific information about the non-plastic, or mineral inclusions. In the pottery, these inclusions are both naturally added and culturally added (temper) minerals.

Five thin-sections of Pot 1 from site GfPa-32 were examined. Mineral fragments larger than 1.0 mm in size were present, but not prevalent. They were igneous rock fragments composed of quartz and plagioclase. These same fragments can be easily seen in a megascopic examination of the Pot 1 sherds. Four sherds had rounded or subrounded quartz particles in the size range 1.0 - 0.5 mm. Rounded and angular feldspar fragments also appeared in this size range.

In some samples, chert appeared in the less than 0.5 mm to 0.2 mm range. Rounded and angular quartz and feldspar appeared in this size range. Rounded to subangular quartz and some feldspar occurred in the less than 0.2 mm to 0.1 mm range, with rare chert and amphibole. Several minerals, including chlorite, amphibole and muscovite, were identified as occasionally occurring in the silt-sized (less than 0.10 mm) category. Angular quartz and feldspar were predominant in this size range. Table 5 lists the mineral identifications for Pot 1.

One pottery thin-section was examined for Pot 2 (site GfPa-41). Its mineral content was similar to that of Pot 1. The mineral identifications for Pot 2 are displayed in Table 5.

The three clay samples were fairly similar to one another, but differed, as a group, from the two pottery samples. Two of the clay samples (2,3) did not have minerals over 0.2 mm in size. A few feldspar, and scant quartz grains appeared in the over 1.0 mm and less than 1.0 mm to 0.5 mm range in Clay 1. Clay 3 had a few feldspar particles in the less than 1.0 mm to 0.5 mm size range. The majority of inclusions in the three clays were of the size range of less than 0.2 mm and silt size (less than 0.1 mm). The identifiable minerals under 0.2 mm in size were predominantly quartz and feldspar. Some inclusions of the silt size range are too small to identify positively, but they are thought to be quartz and feldspar

(D. Schnurrenberger, personal communication, 1985). Clay 1 contained the greatest variety of identifiable minerals of all the clays, since muscovite was detected along with the quartz and feldspar. The mineral identifications for Clays 1, 2, and 3 are displayed in Table 5.

Discussion of the mineral identifications

Mineralogical variability between the Pot 1 samples did occur, as expected of sherds representing different sections of any vessel. The similarities among the Pot 1 samples indicate a consistency expected for any single vessel. The mineralogical analysis detected granitic rock, indicated by the angular fragments of feldspar, quartz, and joined feldspar/quartz in both Pot 1 and Pot 2. These angular fragments are likely cultural inclusions, representing rock crushed specially for the purpose of tempering the clay (Rye 1981:37). Angular quartz and feldspar fragments appear in all size ranges within the two pottery vessels, although in varying quantities per range. Minerals other than quartz and feldspar are rare, with occasionally occurring chert, chlorite, muscovite and amphibole. The latter four minerals are found in granitic rock.

The pottery mineral inclusions are unlike those of the clay in size, quantity, and kinds of mineral inclusions. Pottery manufacture requires the addition of temper, resulting in generally larger and different mineral inclusions in the pottery than in the clay. For the Black

Fox Island samples, all the clays have quartz and feldspar as their smallest inclusions, as do the pottery samples.

Schnurrenberger (personal communication, 1984) and the author noted that the Clay 2 matrix has an especially similar appearance to those of the pottery matrices. This observation indicates that the clay could potentially have been used to manufacture the pottery. A more intensive study of these smaller quartz and feldspar inclusions might confirm or reject this potential association. Unfortunately, there are no observable exotic or rare mineral inclusions which would further characterize the samples. Quartz and feldspar are common to both the clay deposits sampled and Pots 1 and 2. A correlation of the pottery to a geological area was not attempted because there were no distinctive trace minerals to help assign it to a particular formation.

Mineral inclusions and technological continuity in northern plains ceramics

Comparison of Pot 1 mineralogy with SBC mineralogy

The mineralogical data obtained for Pot 1 is here compared to data on the mineralogy of several SBC samples (Bower 1973). This comparison is particularly concerned with those inclusions suspected to have been added as tempering agents to the clay. The mineralogy of Pot 1 consists of:

Igneous rock fragments (quartz and plagioclase) 1.0 mm and larger (up to 10.0 mm maximum noted).

Rounded or subrounded quartz particles and rounded and angular feldspar particles 1.0 - 0.5 mm in size.

Chert, and rounded and angular quartz and feldspar less than 0.5 mm to 0.2 mm.

Rounded and subangular quartz and feldspar less than 0.2 mm to 0.1 mm.

Chlorite, amphibole and muscovite and angular quartz and feldspar less than 0.10 mm.

The identity and angular shapes of some of the mineral components of Pot 1's paste suggest that granitic rock was crushed for use as temper. Some of the mineral inclusions identified in the petrographic examination are undoubtedly naturally occurring, based on rounded shape (Rye 1981:52). Angular granitic rock occurs in all sizes, 1.0 - 10.0 mm, 0.5 - 1.0 mm, 0.2 - 0.5 mm, 0.2 - 0.1 mm, and less than 0.1 mm. Rounded mineral inclusions also occur in all size ranges. Therefore, it is difficult to use size-sorting as a basis to separate out which particles are naturally included from those are not (Hanna 1983:34; Rye 1981:52).

Carolyn Bower (1973a, 1973b) looked at the mineralogy of several classes of SBC sherds from the Morkin site. The mineralogy of those classes with surface finish most similar to Pot 1 (SBC Classes A, C, and M) are here presented:

Class A , Cord-marked class - Granitic temper with major amounts of plagioclase feldspar and quartz, and either minor or major amounts of microcline, depending on the sample slide. Chert particles also are present in Class A

sherds (Bower 1973a:37, Table 1).

Class C ,Fabric/net impressed - Small (less than 0.5 mm) inclusions of quartz and chert. Granitic constituents 1.0- 4.0 mm. Varying amounts of microcline present, from major to smaller amounts. Chert and carbonate particles are also present (Bower 1973a:37, Table 1).

Class M, Woven-fabric impressed - (Also known as Class I in Bower 1973a:37, Table 1). Granitic temper with major microcline. Chert particles were present. In some cases, clay lumps were visible.

In summary, granitic temper predominates for those SBC classes closest to Pot 1 in surface finish and structure. Natural (rounded) quartz and chert inclusions are also characteristic.

Interpretation: Standardization of the tempering process on the Northwest Plains

The specific natures of the mineralogy of Pot 1 and the ceramics from the Morkin site examined by Bower are possibly of some significance to the comparison. The general nature of the mineralogy of Pot 1 and SBC ceramic classes A, C, and M provides useful information to infer continuity in the tempering process.

A similarity of SBC and Pot 1 pottery manufacture technology is indicated by their mineral inclusions. It appears that the use of ground/crushed granite for temper is common to both. Granite constituents are also

naturally-occurring to both, and may indicate some similarity in the origin of the clays used. Bower's study clearly indicates that crushed/ground granite was the apparent preference for tempering material by southern Alberta potters.

In stating that granitic temper is characteristic of the southern Alberta pottery she examined, Bower reasons that the granite particles contained in the ceramics she studied were intentional, cultural inclusions. She assembled supporting evidence based on local geology, the on-site presence of friable granitic pebbles with mineralogy matching the pottery sections, and ethnographic evidence indicating the use of fire-cracked granite for temper (Bower 1973:30). Sherds from other northwest plains sites were compared to the Morkin site sherds to see if there were technological/materials similarities.

Contrary to her expectations, Bower found that the northwest plains pottery technology was standardized, to a certain extent, as to materials used and how they were used (Ibid.:54). She found that the sherds analyzed from sites throughout the northwest plains had "gross technological characteristics" in common. In general, it seems the N.W. Plains ceramics had carbonaceous paste and low porosity, and were low-fired (Ibid.:53). Following Shepard 1963 and Linton 1944, Bower suggested that the Plains ware was suited for use as cookpots (Ibid.:53-54). Bower also observed a correlation between type of temper and surface finish of

vessels at the Morkin site (Ibid.:61).

The author proposes that there may be a culturally reinforced reason for the general use of granitic temper in SBC ceramics. Technically, the use of granitic particles as temper makes perfect sense. Temper is added to clay in order to improve workability and decrease the potential of cracking during drying and firing (Rye 1981:31). In order to meet her/his objective of successfully firing a vessel, the potter must choose a tempering material compatible to the properties of the clay. For primary-technology potters, this decision is based on actual experience or learned information and guidance of other potters. As stated above, clay minerals are the product of granite decomposition. The chemical compositions of clay and granitic temper would be basically similar, comprised of potassium, aluminium, and silica oxides (Ryan 1978:42). The thermal expansion properties of plagioclase feldspar, found in granite, are similar to those of average clays (Rye 1981:27; Hanna 1983a:30).

Comparison of the mineralogy of CLP (Selkirk) ceramics with Pot 1 mineralogy

The temper of CLP type ceramics is described by Hlady (1971:7) as "Fine to medium sand or grit and medium to coarse crushed granite." Hlady compared the CLP temper with the temper characteristics known for Winnipeg Fabric-impressed Ware (Selkirk), and found them to be

coincident (Ibid.:16). The pottery of the Pehonan complex of the Nipawiwan area of Saskatchewan has "prominent" crushed granitic (quartzite and feldspar) temper (Meyer 1981:24). Site FhNa-10, Bushfield West, is within the Nipawiwan area, and this general characterization refers to the mineralogy of its ceramics. Vessel 29 has been described by Hanna (1983:34) as tempered predominantly with feldspar particles 1.0 to 3.0 mm in size.

Pots A-E are vessels from the Bushfield West site which were examined by the author. They appear to have abundant grit, or crushed rock temper. Pots A - E were observed to have angular granitic particles ca. 1.0 to 3.0 mm in size; mica and quartzite particles less than 1.0 mm in size; and silt- and sand- sized micaceous and gold-colored (pyrite) particles. The grit in the paste of Pots A-E differs in appearance from the grit apparent in the paste of Pot 1. However, both the BFI and the Bushfield West temper components are, apparently, derived from crushed granitic rock.

Comparison of CLP mineralogy with SBC mineralogy

In microscopic examination (thin-sections) of sherds derived from surface surveys in Saskatchewan, Bower reports predominantly granitic components for the temper. Samples from a fabric-impressed ware category have quartz and plagioclase and microcline feldspars (Bower 1973:158). A cord-marked category specimen has similar (granitic)

components (Ibid.:157).

In general terms, the mineralogy of CLP ceramics and the related Pehonan ceramics is the same as that of SBC ceramics. Granitic temper, in the form of quartz and feldspar particles, appears to have been the favored addition to clay for pottery manufacture. The size ranges and other minor differences in the composition of inclusions probably reflect differences of preparation and inevitable differences in the geological history of the granitic rock used (e.g., the black micaceous and gold pyrite silt-sized particles observed in the FhNa-10 ceramics).

Granitic temper: A technological correlate for northwest plains pottery

The shared use of crushed granitic rock as a tempering medium for clay may, at first, seem like an insignificant and general coincidence for the pottery examined in this discussion. However, when one considers that there were probably other materials available to the CLP and SBC potters suitable for tempering clay which were not used, the shared selection for crushed granite is more significant.

The predominant use of granitic temper has been noted by analysts of both plains and southern boreal forest ceramics. Corenblum and Syms (1977:2) state that "most Plains ceramics are tempered, and grit (crushed rock) is the most frequent temper found in the paste." In further characterization of the grit, they state that "[Grit] was

easily obtained from friable granites, schists, or gneisses, all of which are common on the Northern Plains." (Ibid.:5-6). Corenblum and Syms provide ethnohistoric documentation of the use of crushed friable granite. In a discussion of CLP type ceramics, Meyer states that "the use of crushed granite is a universal characteristic" (Meyer 1978:8). To the author's knowledge, there has not been any discussion speculating why the technological correlate of granitic rock temper is shared by CLP and SBC pottery wares.

Temper and technological continuity

The shared or coincident use of crushed granitic rock as temper may indicate interaction between CLP and Late SBC potters. Knowledge of the right kind and amount of temper to use is an important part of pottery technology, influencing the success of ceramics manufacture (forming and firing), and use; that is, cooking, storage, or transport of goods (Sternquist 1972:32-33; Rye 1981:26,27). As any kind of knowledge is acquired through actual experience or communication of experience, potters must learn about temper properties through trial and error (experimentation), or from other potters, and usually by both means. Where a body of knowledge of temper properties exists, it is to the advantage of neophyte potters to obtain and observe this knowledge. Or, where two culturally different groups of potters are in contact with one another, if one group possesses a more effective pottery technology, including

tempering procedures, it may be adopted or adapted by the less successful potters.

Along with the constraint of local geological resources and their constant evaluation of the materials available to them, cultural conventions of materials to use for temper are basic to a group's pottery technology. How the cultural conventions of prehistoric temper use were originally arrived at is not well understood (Hanna 1983a:17; Corenblum and Syms 1977:14); but it is archaeologically observable, by noting consistent patterns of temper in pottery, that they existed and were perpetuated. The standard explanation for this continuity and consistency of practice is that potters are inherently and extremely conservative; and once they find the formula for success, they adhere to it (see Hanna 1983a:17). Thus, the coincidence of kind of tempering materials used for CLP and SBC may lie in what Shepard (1976:163) terms "stability of custom with respect to choice of temper", where, in a geographic region with certain mineral resources, over time potters selected those appropriate for their ceramics, and then maintained the use of these distinctive materials in all their pottery production.

While the convention of using crushed granitic rock as temper may have been independently discovered and implemented by CLP and SBC potters, it may also be an indication of communication between the two groups. Sternquist (1972:31-32) proposes, with reference to

tempering materials, that a study of continuity in production processes may aid in the detection of social patterns accompanying pottery production practices.

IV. Chapter Four - The Use of Pottery Data for Historical Questions

A. Inquiry one: Connections between CLP and SBW

Hanna (1983a) considers the possibility of an interactive exchange of ceramic technology information by Laurel and Avonlea potters to explain the similarity of certain decorative and technical traits of Laurel and Avonlea ceramics. She proposes four hypothetical situations by which information on ceramic style and technology could have been exchanged. The four situations are: 1) visiting between groups; 2) exchange of information through direct contact between a group moving into a new territory and an antecedent population; 3) marriage of a woman from one group into another group, requiring that she change her place of residence; 4) trade of pottery from one group to another (Hanna 1983a:18-21). The two situations of visiting and exchange of information between newcomers and long-term inhabitants (Ibid.: 19-20) are most attractive of the four for a proposed exchange of CLP-SBC ideas on pottery construction and decoration.

Situation One

The author has adapted Situation One from one of Hanna's hypothetical situations (Ibid.: 19). It states that potters of the SBC group, who may or may not have had a previous knowledge of pottery manufacture, visited and

observed the activities of CLP potters. The visiting group returned to its home region and began to manufacture the SBC ceramics using methods and devices seen used by the CLP potters. Depending on the degree of attention in observation and understanding of what they observed, the SBC potters could 1) exactly replicate what they had seen, with some changes necessitated by differences in local materials; 2) almost exactly replicate the methods of construction used, with modifications due to nonprecise observation of certain parts of the procedure, and possibly also due to differences in local materials; or 3) choose to replicate certain steps of manufacture observed, with modification in construction according to personal experience or convenience, using local materials.

The results obtained from the comparison of CLP - SBC ceramic technology favors options 2) and 3) of the situation presented above. Firstly, there is certainly a difference in clay materials used. The actual sources of the granitic rock for temper differ, but the general use of granitic rock is shared. This pattern might indicate that the SBC potters recognized that they could use local clay resources, without undue technical penalty (failure); but that their ceramics had a greater chance of paralleling the success of the CLP potters if they used the same variety of temper materials. Secondly, there were enough differences noted in the reconstruction of manufacture technique to indicate that the CLP ceramic construction procedures were not exactly

followed. Thirdly, the presence of punctates on the rim of SBC ceramics indicates some sort of ideological or functional correlate with CLP pottery.

If option 2 of the proposed situational model is followed, the SBC group was likely unfamiliar with pottery-making. While visiting the CLP potters, they observed pottery manufacture. Later they attempted to replicate the process, obtaining the appropriate materials and following the construction steps to the best of their recollections. Variation between CLP and SBC construction may have occurred due to imperfect recollection and/or materials differences.

Option 3 of the model would most likely occur for a group familiar with pottery manufacture incorporating some new techniques with their old ceramics technology. This option says that the SBC potters observed CLP potters and modified the CLP process to achieve certain results.

Situation 2

Hanna (1983a:20) presents a situation involving an exchange of information between two different groups of potters when a new band moved into the territory occupied by another band. The new group obtained information on raw materials sources from the indigenous group, and they made their pottery, with modifications of their accustomed procedure necessitated by the differences in the properties of the new clay (Ibid.: 21).

A slight variation on this situation proposed by Hanna provides a model for CLP - SBC interaction, which is suggested by the typological and the proposed technological similarities of the two pottery types. In this model, CLP potters moved to a region occupied by a band(s) which made SBC ceramics. The CLP potters may have accompanied other members of a pioneering band, or they may have been women potters who married into the SBC band. The model of marriage for movement of women potters into new groups has been particularly espoused by Hanna (1982, 1983a). Whatever the means of entry into the new region, the intrusive CLP potters obtained information on the location of raw materials satisfactory for ceramics manufacture from the indigenous SBC potters. When they attempted to use the raw materials in their traditional CLP process sequence, the CLP potters found that technical adjustments were necessary. At this point, the CLP potters could experiment until satisfactory results were achieved; and they could observe the process sequence of the indigenous SBC potters to see how best to manipulate the new raw materials. Based on what Arnold (1985:236) says about the conservative nature of forming patterns and related motor habit patterns of potters, the following reconstruction will be oriented toward a scenario where the CLP potters tried to adapt their old habits to the new materials.

The exterior of the traditional CLP vessel was in contact with a fabric item during its plastic stage. The

transplanted CLP potter continued this action, which was probably a means of parting the ceramic from a mold. Thus the primary forming technique of molding used in CLP truncated fabric-impressed ceramics was continued for the ceramics made by the transplanted CLP potters. Anvil marks inside the SBC vessels indicate the use of a beating technique to pound the clay into the mold to form the walls. This method varied from the CLP pressing and drawing method, and may have been necessary due to decreased clay plasticity in the new resource region.

This variation in the manufacture process, in addition to the thickness of the walls and shoulder thickening, suggests that the manufacture process for these new ceramics may have been modified from that used for the traditional CLP pottery due to difference in clay quality. The clay used for traditional CLP ceramics was greater plasticity and strength, so that the walls could be made thinner and the shoulder could be molded as one piece with the base. With the poorer quality clay of the new region, the transplanted CLP potters had to add a slab-coil to the formed base to build the vessel higher, forming a more angular shoulder than seen on the traditional CLP vessels. The shoulder had to be thickened to strengthen it. The walls of the vessel were further strengthened by addition of a layer of clay atop the initial walls.

The strength of the clay used for the traditional CLP vessels was great enough that a pot could be removed from

the mold while still plastic to smooth the exterior and paddle it, a gentle form of beating to shape the vessel. The SBC fabric impressed vessels were not removed from the mold or the fabric item because the potters decided to dispense with that step due to personal choice or because they knew the clay was not strong enough to be self-supporting. The punctates were added to the SBC vessel for a reason related to the pot's function as a cookpot; for transport (leather thongs, strung through the punctured punctates, to sling over the shoulder?); for good luck or other ideological/religious reasons; to affirm the CLP-related ethnic identity of the potters; or for any one of a number of possible reasons.

Discussion of the situational models

The two models should be archaeologically visible as change in ceramics technology and design at SBC sites. Byrne has noted differences in the SBC ceramics which he feels are linked to change and development within the complex from Period I (A.D. 150/250 - 1150) through Period II (A.D.1150 - 1700) to Period III (A.D. 1700 - 1870)(1973:341,353). He feels that, because general similarites continue throughout the SBC manifestations, the differences noted represent "internal development" and "indigenous change."(Ibid:353). The effects on pottery technology suggested in the models of CLP -SBC visiting and CLP migration would be so subtle as to appear as internal or indigenous change.

The model whereby CLP potters move into the southern Alberta region closely parallels a suggestion by Byrne that the fabric-impressed vessels seen in the SBC collections reflect "trait-unit intrusion from Cree material complexes." (1973:529). In fact, he further states that "within the Saskatchewan Basin complex the apparent mixture of pottery features derived from the Cree and ceramics attributed to the Blackfoot or Kutenai could be the result of simple diffusion of manufacturing ideas." (Ibid.). Byrne cites Wright's 1968 marriage-incorporation model when he suggests that Cree women moved into the resident Alberta population, leading to trait-unit diffusion into the SBC ceramics.

With regard to the use of technologically based attributes to differentiate between ceramic complexes, Hanna concludes, based on her Laurel and Avonlea data, that "there is no one technological pattern common to all vessels contained within any one ceramic complex."(1983a:42). She recognizes that the numerous factors involved in pottery production are heavily influenced by geographical factors or circumstances, which make it difficult to isolate the cultural factors which might also influence production features (Ibid.). However, the isolation of these cultural factors may not be impossible to effect. While not able to define a pure version of either Avonlea or Laurel ceramic technology, Hanna was able to recognize a mixing of Laurel and Avonlea technology which may have resulted from adoption of a Laurel forming technique to use with the "traditional

Avonlea paddle-and-anvil techniques."(Ibid.:44). A similar situation may have resulted from CLP-SBC interaction.

Non-cultural factors and pottery manufacture

The author proposes that the thinness of the CLP walls compared to the thicker SBC ceramics walls is a significant difference in form and structure. The difference may be attributed to differing functions of the vessels, or due to differing criteria as to what a pot should look like. Alternatively, the difference may be based in technical expertise. Thin, self-supporting walls as seen in the fairly large CLP vessels are difficult to achieve, and may indicate a greater familiarity with or higher degree of skill in pottery-making by the CLP potters over the SBC potters. Or, the difference may be based in materials difference, as in plasticity and strength of the clays used for the SBC pottery and the CLP pottery.

The author was interested in the possibility that the difference in wall thickness between SBC and CLP ceramics may be partially attributed to a difference in the characteristics or properties of the clays used. Rice (1978:519) states that contemporary Chinautla pots are "high quality, thin walled...strong and durable," seemingly due to the use of a superior white (kaolinitic) clay. The source used for the FhNa-10 vessel(s) may have been of a higher quality for pottery manufacture than the source used for Pot 1 and other thick-walled SBC ceramics.

Although a link between materials and vessel form may be found through the comparison, the author does not intend to argue in favor of "technological determinism" as an overriding force in shaping a vessel. The materials may limit the potter's manipulations, yet s/he still has a choice, based on traditionally and personally derived knowledge of what methods and steps to use to manufacture a vessel to achieve a desired final form.

Clay properties and workability

Workability of clay refers to its suitability for pottery manufacture. Clays must be plastic, but not overly plastic. They must be strong and self-supporting when molded to shape. The clay mineral composition of a clay specimen has a large role in determining these properties. The formation history of clays and the depositional processes they undergo (Ryan 1978:42-43) determine clay mineral characteristics. Each of the clay mineral groups (kaolinite, illite, montmorillonite, etc.) has distinctive properties which affect its suitability for pottery-making (Rye 1981:29-30).

The geologically and chemically determined clay characteristics germane to workability include the crystalline structure of the minerals and their sizes, stability within the clay mineral structure, presence of non-clay minerals and organics, and orientation and distribution of particles and binding forces (Rye 1981:29;

Ryan 1978:58). These fundamental clay mineral properties may affect workability. For example, unstable forms of kaolinite found in certain clays have "greater plasticity, dry-strength and wet-to-dry shrinkage:" due to a smaller particle size, which creates a greater surface area for the kaolinite particles (Ryan 1978:60).

Clays used by primary technology potters are usually a combination of the clay mineral groups. Natural clay group combinations (secondary deposits) and artificial combinations (mixing) modify the disadvantageous effects of inferior clays by adding the advantageous effects of clays superior for pottery.

The effects of plasticity and dry-strength on vessel form and wall thickness

Plasticity refers to the property which permits clay to be shaped using an applied force, without fracturing. It allows shape retention even when the force is removed or reduced (Ryan 1978:13). Dry-strength refers to the strength of clay after it has been shaped and dried and before firing (Ibid.:24). These two properties are associated with one another in a clay, and are "due to the fineness and plate-like shape of the clay particles" (Ibid.). They are here considered of equal importance in vessel formation. The manufacture process and the final shape of a vessel depends on both properties.

Manufacturing process can also affect dry-strength. When in the plastic state, clay particles are randomly organized. The particles will align themselves parallel to the direction of a force applied to the clay mass. Greater dry-strength results from increased contact of the particle flat faces with one another. According to Ryan (1978:25) "The larger the force used in plastic making, the greater will be the particle alignment and the greater the dry-strength." This engineering principle is reflected in the secondary formation practice of beating which has been suggested as part of the Clearwater Lake Punctate manufacture process.

The wall thickness differences, shoulder thickening, and other structural differences between Pot 1 (SBC) and reconstructed FhNa-10 vessels (CLP) suggest differences in the plasticity and dry-strength of the clays used for the two wares.

Chemical differences and material (clay) variability

Hanna (1983a:13-14) states that primary technology potters of the northern plains were aware of clay deposit variation, and used the knowledge to help them select their materials. Undoubtedly a potter would be aware of the clay resource range in his/her geographic locale and make the best use of this knowledge, recognizing the ultimate effect of clay selection on his/her products. However, prehistoric primary technology potters probably would not have explained

their selections of clay in terms of the geological history or clay mineral structure characteristics.

In trying to understand what sort of variation might be significant to differences in the workability of clay, the author considered chemical-elemental content of the clay as a possibility. It may be that the presence of a certain chemical character, or fingerprint, might accompany those clays of greatest or best workability. According to Goffer (1980:111), "Clays are better characterized by their structure than by their composition." because clays which are similar chemically may have very different physical and technological characteristics. However, differences in chemical composition may be symptomatic of impurities in a clay which could, conceivably, affect the workability (Ibid.). Chemical data on two different vessels was available to the author, who decided to make a comparison of the two data sets.

Elemental-chemical comparison of Pot 1 and FhNa-10:29

The INAA results of Pot 1 provide elemental data for the clay used to make it. Comparative elemental data for an FhNa-10, Clearwater Lake Punctate variant vessel was provided by an undergraduate honours research project at the University of Alberta. INAA to characterize FhNa-10:Vessel No. 29 was initiated following the Black Fox Island Pot 1 neutron activation analysis. M. Melainey analysed a vessel from the site of Bushfield West (FhNa-10); the site is the

subject of a doctoral dissertation (in progress) by T. Gibson. Melainey and Gibson (personal communication) hoped to confirm elemental homogeneity within Vessel 29 (see Perlman and Asaro 1969 for results which also confirm chemical homogeneity with a vessel). The author permitted the data for Pot 1 to be used in comparison with Vessel 29 for the research project. Melainey's data shows that Vessel 29 is elementally different from Pot 1.

The results from the chemical analysis of FhNa-10:29 can be used to provide data on the specific chemical composition variation of a SBC representative vessel and a CLP representative vessel, and indicate what the specific chemical variation might mean in terms of difference in materials suitability and manufacture methods. With a sample size of two, no claims for statistical accuracy or representativeness of the results can be made. However, the author will state that the comparison does provide some interesting data and a departure point for discussion of how the chemical differences in the clay materials (due to locations of deposits and geological factors thereof) may have affected manufacture technique and vessel form, leading to obvious structural differences between Pot 1 and FhNa-10:29.

Table 6 lists the raw data of element content (in ppm) for Pot 1 and FhNa-10:29. The data represent the ranges of element quantity (in ppm) for ten elements detected in both pottery samples. Pot 1 is represented by twelve aliquots, or

individual samples; and FhNa-10:29 by thirteen aliquots.

Comparison of the two data sets in Table 6 demonstrates some obvious chemical differences between the two vessels. FhNa-10:29 has higher values of samarium (Sa), uranium (U), cobalt (Co) and arsenic (As) than does Pot 1. The element scandium (Sc) occurs in greater quantity in Pot 1 than in FhNa-10:29. Values for europium (Eu), antimony (Sb), iron (Fe) and sodium (Na) overlap for the two samples, indicating similar quantities of those elements for the two vessels.

An implication of the chemical-elemental differences

Quite obvious chemical-elemental differences are present between the two vessels. In light of their also obvious structural differences, the author proposes that these chemical composition differences may be significantly related to factors in the degree of workability of the clay, which must ultimately influence the final results in vessel manufacture. As previously stated, the dry-strengths and plasticity of the two clays used, as evidenced by wall thickness/thinness and manufacture method indications, were different. It appears to have been a priority of the SBC potter to strengthen and stabilize the walls by thickening them.

There is a lack of literature dealing with how clay workability is affected by the presence of certain levels of the ten elements in this comparison. Therefore the author is unable to state conclusively that the differing amounts of

Sm, U, Co, As and Sc did or did not affect the clay workability. However, the author believes there is potential in a line of investigation into clay chemical characteristics and their probable effects on manufacture method and vessel structure. This line of investigation would shed light on clay selection and use practices of prehistoric potters, and specifically whether they selected what can be recognized chemically as superior quality clays.

The Selkirk-Saskatchewan Basin complex connection: Directions for future archaeological research

The situational models presented above, suggesting interaction between CLP and SBC potters, are not intended as an explanation or interpretation of the technical and stylistic similarities seen for the two pottery ware types. Rather, they are presented to guide future interpretation of the archaeological facts. Certainly there is a connection between the southern Alberta SBC defined by Byrne, and the Selkirk focus of Saskatchewan and Manitoba which appears as a number of manifestations throughout the region of west-central Canada.

Byrne (1973) speaks of ceramic complex change in terms of persistent modes, partial-sequence modes, and transitory modes. These modes are attributes having chronological significance within the SBC. The significant attributes are related to surface finish, vessel form and decoration (Byrne 1973:349). As discussed in the presentation of the processes

involved in pottery manufacture, many or most of those attributes are affected by the method and techniques used in forming the vessel. If the modes selected by Byrne as representative of change throughout the complex were explicitly linked to the technical process of pottery-making, the results could be compared to the CLP manufacture method. This approach would supplement the use of stylistic data (surface finish description, presence of punctates, shape of lip, rim curvature) which is currently used to hypothesize a Selkirk - SBC connection. The technical features of selection of raw materials and methods of formation into the culturally-desired vessel form underlie a number of the predominantly stylistic features currently used for pottery analysis. This fact should be recognized and used for cultural interpretation.

The Pehonan Complex: Transitional between CLP and SBC?

As previously stated, in discussing pottery traditions of Western Canada, Byrne (1973:405) places pottery from Saskatchewan transitional between Selkirk ware and SBC ceramics. This idea is further advanced by Meyer (1981) in his discussion of the Pehonan complex of the Nipawin, Sask. area. Initially, Meyer had identified the Nipawin ceramics as CLP, based on the presence of a number of definitive and correlative attributes. At second look, some attributes, particularly angularity of shoulders for the Nipawin pottery compared to rounded CLP shoulders, seemed to indicate a

major difference in form (Meyer 1981:24). These different ceramics were assigned to the Pehonan complex.

Meyer (1981:27) feels that several attributes of Pehonan ceramics, particularly the angularity of the shoulders, are related to the late SBC ceramics.

As stated by Meyer (1981:30):

> The pottery of the Pehonan complex incorporates traits which reflect contacts both to the north and to the south. It is apparent that the closest relationship is with Selkirk ware, particularly as the latter is expressed in the Clearwater Lake complex...

Meyer characterizes the projectile points associated with the Pehonan complex ceramics as grasslands/prairies forms (late triangular and side-notched). Stone adze blades and barbed bone points such as found in Clearwater Lake southern boreal forest assemblages are present in the Pehonan complex. The attributes of the Pehonan assemblages led Meyer to propose that the complex is "...transitional between those of the forests and prairies, which can be assigned neither area and, therefore, must stand alone."(Ibid.:33).

Meyer's interpretation of the archaeological data draws upon ethnohistorical data on ethnic identity and group movements (Meyer 1981:33, 1980:14-15). He states that:

> The Pehonan complex, therefore, appears to have been the product of a people intermediate in culture between the occupants of the northern forests and of the grasslands. It seems likely that these were Algonkians whose culture was similar to that of the Crees who occupied this region historically. In the study area [Nipawin] these people may have moved seasonally between the southern edge of the boreal forest, with its spring fisheries and varied faunal

> resources, and the parkland with its winter aggregation of bison (1980:16).

Meyer (1980:15) dismisses an Assiniboine ethnic identification for the Pehonan complex potters. He recalls that Byrne (1973:515-531) suggests that late SBC ceramics were manufactured by proto-Blackfoot.

In a recent (1984) re-evaluation of the Pehonan complex, Meyer questions whether it really is distinct from Clearwater Lake proper. He indicates that Pehonan is not as highly differentiated from Clearwater Lake as first proposed, but he reaffirms the establishment of the Pehonan complex to characterize the Nipawin area assemblages and the presence of Pehonan in the Selkirk composite (Meyer 1984:4,7).

Remarks

The author proposes that technologically-based attributes, in addition to the stylistic and formal attributes currently cited, are necessary in the identification and differentiation of Pehonan complex and Selkirk composite ceramics so that the exact nature of the relationship between them and SBC ceramics can be studied. It seems that a good deal of the confusion and uncertainty surrounding the cultural identifications of pottery complexes hinges upon a reliance on the current taxonomies based mainly on stylistic (decoration, surface finish) and formal attributes of ceramics. The descriptions and comparisons of paste and temper characteristics have been a

step in the right direction, but it does not suffice if really conclusive interpretations of the technical process and accompanying cultural dynamics are to result.

In conclusion to this section on hypothetical historical connections, the author will make a hypothetical statement:

Saskatchewan Basin complex ceramics are a structural and stylistic variant of Selkirk ware.

Certain SBC ceramics (including Class A and Class M) are stylistically (surface finish, punctates) linked to certain Selkirk (Clearwater Lake Punctate) ceramics. There is an indication that technical similarities (surface finish, structural features, and temper) can be cited to indicate a cultural connection between the two. It is entirely possible that Selkirk potters of the southern boreal forest may have been in contact with SBC potters of the plains, either within one or both of those two vegetative-geographical zones, or within the parkland region. (See Gibson 1983 for reference to parkland-based interaction of plains and boreal forest ethnic groups; also Hickey 1974 for a discussion of the importance of ecotone areas such as the Aspen Parkland for human utilization of resources; and Doll 1982 for a case study related to these ideas).

The combination of both stylistic and technical similarities between two ceramic wares is a strong indication of contact between the potters who made the

wares. Stylistic features (surface finish, decoration and vessel form) and technical features (surface finish, vessel formation processes and raw materials) shared by CLP and SBC wares indicate an interaction between two groups of potters.

B. Inquiry two: Hypothetical situations for the presence of Pot 1 on Black Fox Island

The following hypothetical situations were considered in deriving a model of how Pot 1 may have arrived on Black Fox Island. Hypothetical situations 1 through 4 refer to a south to north movement of influence or contact. Hypothetical situations 5 through 7 address the possibility of north to south influence to explain the presence of Pot 1 on BFI.

South to north influence or contact

Hypothetical situation 1 proposes manufacture of Pot 1 in the Lac La Biche area, possibly on Black Fox Island, although not of clay sources tested from BFI, by people who learned the craft from southern potters. Hypothetical situations 2, 3 and 4 propose that Pot 1 was transported to GfPa-32 on Black Fox Island, through either trade, marriage or migration from southern Alberta. These hypothetical situations are partially based on information gained through testing Hypothesis One. Hypothesis One stated that Pot 1 was manufactured on Black Fox Island, of local clay. Hypothesis One was rejected because local clay sources were tested and

did not chemically correspond to Pot 1. It has been established that Pot 1 was manufactured in late Saskatchewan Basin ware style and using one technique of manufacture of late Saskatchewan Basin ware. Therefore, it is possible that Pot 1 was manufactured in southern Alberta, where other SBC pottery has been found.

Although the data from this study shows that clay from Black Fox Island's east shore was not used to manufacture it, Pot 1 may have been produced in the Lac La Biche region by a resident group using other available clay sources. To develop this explanation for the presence of Pot 1 on Black Fox Island, the presence of clay sources other than on the island has to be established. A local resident reports that clay is available on the north shore of the lake, ca. one-half mile by water from Black Fox Island (K. Maccagno, personal communication); and there may be other sources in the region. Or, pottery may have been produced on BFI of the beach clays (1,2,3) tested, but this pottery was not recovered in the archaeological investigation.

Ideas of pottery manufacture may have diffused from a population in southern Alberta to a northern population resident at Lac La Biche. The similarity in style and technical approach of Pot 1 to the ceramics of the southern Alberta-based SBC (late variant) suggests that the production of the vessel could have been influenced by ideas from the Saskatchewan Basin complex. The author believes there are three lines of support for a hypothetical

situation that the initial ideas of pottery manufacture diffused from southern Alberta to northern Alberta. Firstly, Pot 1 is typologically close to SBC. Secondly, much less pottery has been found in the parkland/boreal forest zones of north and north central Alberta than in the plains region of southern Alberta. Thirdly, the southern Alberta pottery incidences have a greater time depth, particularly for locations such as the Morkin site. Therefore, the pottery industry appears to have originated and to have been stronger in the southern Alberta plains than in the more northerly regions of the boreal forest and parkland zones. An alternative to this idea of southern Alberta influence will be discussed in hypothetical situation 5, below.

Trade would have allowed a vessel manufactured by potters of the Saskatchewan Basin Complex group(s), using materials from their home region, to be obtained by a northern population. However, the pottery vessel present on BFI represents only half of a trade exchange between the southern group and the resident northern group. A reciprocal item might be documented archaeologically.

Ethnohistorical references to trade between northern and southern groups would serve to establish the fact of trade, and might also mention the goods exchanged. A rather whimsical reference to trade appears in McClintock (1910), who describes trade links between Blackfoot (south) and Cree (north):

> The Blackfeet had a Love medicine, which they called Ito-wa-mami-wa-natsi (Cree medicine), because it was

> generally obtained from the Crees, who were specialists in its manufacture...[E-kum-maken] made a long journey north to visit a Cree medicine man, from whom he purchased some of the Love medicine.(1910:190).

McClintock further reports on the value of this love potion, stating that "The Blackfoot have always been ready purchasers of Love medicine, for which they paid the Crees a horse, or even more."(Ibid.:191). Whether or not a clay vessel would have been adequate payment for a quantity of this Cree love medicine is unknown. Certainly there may have been other materials and or services exchanged between Blackfoot and Cree for which a pot may have served as payment.

Direct application to the BFI problem of a reference to trade between Cree and Blackfoot relies on an assumption that Cree were resident in or visiting the Lac La Biche area in the late prehistoric period at about 1520 A.D. An historic ethnic identity for the groups inhabiting and using the LLB region has not been satisfactorily determined to date, as ethnohistoric records are inadequate and confused on this account. Once the archaeological record for northeast Alberta has been adequately researched and interpreted, ethnic identity may be traced. Attempts to assign historic ethnic identity to sites and assemblages of the southern boreal forest, based on the current body of archaeological information, can only be premature and misleading.

Marriage of a plains potter (woman) into a southern boreal forest-based group may also account for the presence of Pot 1 on Black Fox Island. The woman may have either brought a pot along from her southern Alberta home, or she may have manufactured it in the Lac La Biche region, of local resources.

The occasional residence in and use of forest resources by grasslands peoples is frequently posited to explain the 'intrusive' plains artifacts in the boreal forest. This line of thought sees the transitional zone between the northern forest and southern grasslands as an area used by northern and southern groups either simultaneously or interchangeably. The parkland region of Western Canada is proposed to be a transitional zone in terms of vegetation and culture group economic activity (Losey 1978; Hickey. 1974). The southern limit of the boreal forest, where LLB is located, would fall within this transitional area.

A migratory group from the plains may have travelled to LLB to exploit the resources of the area as part of a seasonal schedule, or in response to a deficit in usual plains resources at a certain time (resource crisis). The apparently small group of people who inhabited site GfPa-32 had brought along at least one pottery vessel for cooking purposes as evidenced by carbon incrustation on the interior rim.

What sort of late prehistoric plains-grasslands group would migrate to a lake in the southern boreal forest? One

suspects that it would be an entrepreneurial, pioneering group with prior or quickly-acquired knowledge of how to subsist in their 'new' forest environment. Perhaps this migrant group from the grasslands, with their punctated SBC variant pot and Plains lithic technology, were members or descendants of a group of CLP potters and others originally from the forest of Saskatchewan which settled within a SBC group. As people who were previously familiar with life in the forest, they were well-suited to move out of the grasslands and north to LLB. Their northward migration may have been a permanent band shift, or it may have been seasonal, with the migrant group rejoining the main body of the southern-based group.

Northern primacy of influence on SBC (late variant) ceramics

Hypothetical situations 5 through 7 explore the possibility that the point of contact for ideas contributing to the manufacture of Pot 1 was in the boreal forest/parkland zones of north and north-central Alberta. These hypothetical situations are in contrast to Hypothetical situations 1 through 4 above, and they advocate movement of ideas from Clearwater Lake Punctate potters directly through the boreal forest and parkland regions and then to the southern plains of Alberta.

Production of Pot 1 may have occurred on Black Fox Island according to the logistical precepts outlined above. Ideas of design and construction from CLP potters were

transmitted to the Lac La Biche region. This transmittal may have occurred when an individual of a band resident in the Lac La Biche region returned from a trip to an eastern region where he or she observed CLP pottery manufacture. The individual attempted to emulate the process and produced Pot 1. The ideas of CLP design and manufacture were later conveyed to other areas of the boreal forest and parkland zone and to southern Alberta, where they were adopted by SBC potters to result in a variant of late SBW. This hypothetical situation could also contain the supposition that ideas of CLP manufacture were transmitted to another or other sites within the boreal forest/parkland zones before arriving at Black Fox Island.

Marriage of a CLP potter into a group of the boreal forest/parkland zone of north and north central Alberta may account for the presence of Pot 1 on BFI. The transplanted potter may have produced her pot out of local resources in a form adapted from CLP type. An alternative scenario within this hypothetical situation is a situation where a woman from the southern boreal forest of Alberta married into a CLP group, and then returned to her native area, bringing with her ideas and practices of CLP manufacture. The ideas from CLP may have later diffused south in a modified format to become incorporated into the SBC.

A migratory group from the CLP zone may have moved into the Lac La Biche area and produced Pot 1 as a new regional adaptation (to local resources or other conditions) of CLP.

These people who had moved across the boreal forest/parkland zone may have later moved to the southern locus of SBW production to visit or for seasonal or other temporary resource exploitation where they produced ceramics which have archaeologically been recognized as a late variant of SBW.

In hypothetical situations 5 through 7 above, which encompass scenarios of diffusion, marriage and migration, Lac La Biche, and specifically BFI have been introduced as the hub of the interaction between CLP boreal forest/parkland peoples and more southerly regions of Alberta only as an abbreviated and convenient means to illustrate the possibilities. It is entirely possible that the Strathcona site or another site in the Alberta boreal forest or parkland was the area of first influx of CLP ideas or people leading to the SBW variant here discussed.

Remarks

The number of hypothetical situations and possible scenarios for the presence of Pot 1 on BFI and its potential links to CLP and SBW are many, and they vary, no doubt, according to variation in hunter-gatherer social, political, economic, religious and ideosyncratic behavior. The possibilities mentioned here can be matched by other, equally viable scenarios. The author has here stated those which seem to be most obvious or viable to her.

C. A model for Late Prehistoric settlement on Black Fox Island

At this point, the author will advance a model to explain Black Fox's settlement history during the Late Prehistoric occupation of GfPa-32. The model will draw upon information obtained through the Pot 1 analyses and results described in this thesis. Hypotheses to test the model will be advanced; these hypotheses are available for future research and will not be addressed in this thesis.

The model advanced here is based on hypothetical situation 4, mentioned above. The model states that Pot 1 was manufactured in southern Alberta by potter(s) of the SBW tradition, and was transported north by a group of people who exploited the Lac La Biche resources as part of a regular, seasonal schedule or as part of a permanent movement to the southern edge of the boreal forest.

To test the model advanced above, it must first be proved that Pot 1 was not manufactured in the LLB region. A hypothesis such as Hypothesis A, below, should be framed and investigated.

Hypothesis A:
Pot 1 was made in the Lac La Biche region, of clay from BFI other than the sources tested, or of clay from elsewhere in the LLB region.

The lack of correlation between Pot 1 and the clay tested indicates that the vessel was not manufactured of

clay from those sources on Black Fox Island. A clay source is known for the north shore of Lac La Biche, opposite BFI; and it is of workable quality (K. Maccagno, personal communication). Perhaps clay from this location, or another location in the Lac La Biche area, was used to manufacture Pot 1; and the vessel was later transported to the island. Or perhaps clay was transported to Black Fox I., and was stored on site GfPa-32, possibly as evidenced by the clay feature on-site. The presence of the clay source on the north shore was unknown to the author until recently, and so samples were not tested. However, future research into the source of clay for Pot 1 should test the north shore clay.

If a local clay source is found to match the chemical composition of Pot 1, it could indicate a) movement of a SBW producing group or potter into the Lac La Biche region; or b) diffusion of traits through direct or indirect contact between the Lac La Biche population and a SBW population.

Once Hypothesis A has been investigated, or concurrently with the investigation, Hypothesis B should be investigated in an attempt to prove or disprove the model of BFI settlement.

Hypothesis B:

Pot 1 was manufactured on a site outside the Lac La Biche region, possibly in southern Alberta. Pot 1 was transported to GfPa-32 from the site of its manufacture through trade or migration.

The test implications of Hypothesis B are as follows:

1. If the pottery found on site GfPa-32, Black Fox Island, is from a region outside of Lac La Biche, it should have attributes in common with pottery types known from that region. Pot 1 is a variant of late SBW, known from the Morkin site, southern Alberta, and from the Strathcona site in Edmonton (Figure 2).

The geographic region of known occurrence of SBW seems to be centered in southern Alberta, the major known locus being the Morkin site in southern Alberta (Byrne 1973). Saskatchewan Basin ware has been identified at the Strathcona site near Edmonton and in the Cold Lake region of Alberta. Saskatchewan Basin ware has not been identified for regions north of Lac La Biche, although pottery of unknown type has been found at Calling Lake.

The attribute similarity in itself does not indicate manufacture on the plains. Diffusion of SBW traits northward may have determined the appearance of Pot 1. For this reason, clay samples from the north shore of Lac La Biche should be tested and compared to Pot 1 to see if the ceramics had been manufactured in the Lac La Biche region (Hypothesis A).

2. If Pot 1 had been manufactured at a locality other than Black Fox Island, it would have been made of clay and temper indigenous to that locality or site of manufacture.

The rationale behind this statement is that primary-technology potters normally use materials as close

at hand as possible. Sometimes clay, especially when highly valued for specific properties, will be carried some distance from the site of procurement to the site of manufacture, but it has been documented from ethnographic observations that, most often, clay sources will be obtained within 1 to 7 km of a settlement (Arnold 1985:50).

One appropriate analysis to investigate Hypothesis B involves the identification and comparison of trace elements of southern Alberta and other non-local clay samples to Pot 1. A foreseeable problem involved in comparing Pot 1 with raw clay from areas outside the Lac La Biche region is the low probability of coinciding with the raw clay source. A commitment to finding the clay source would involve extensive testing beyond the scope of this project.

An alternative solution to testing raw clay from other areas would be to compare the elemental content of Pot 1 with the elemental contents of other pottery samples such as those from the Morkin site, the Strathcona site, Calling Lake, Cold Lake or Wappau Lake (see Figure 2). Interaction between one or all of these sites and Black Fox Island may have contributed to the presence of Pot 1. This experiment must be left the future, as it is beyond the scope of this study.

Testing of these two hypotheses would constitute only part of the investigation into the model advanced. Other factors to be investigated are the cultural identity of the BFI group and whether they were permanently established in

the southern boreal forest or seasonal visitors; or whether there may have been trade or marriage connections between a southern and more northerly population.

Remarks

The model presented above does not directly address the possibility of northern primacy for the Pot 1 SBW variant via direct contact with CLP ideas and/or people, with transmission of these ideas south. Some of the tests of other site ceramics mentioned in Hypothesis B might lead to further investigation of this possibility. For instance, one scenario might involve a southern Alberta plains origin for the BFI inhabitants. These people may have been manufacturers of SBC pottery who adopted some CLP traits from the boreal forest/parkland zone to the east of them. Later, the migrant plains group, or an individual, returned south, taking the CLP ideas with them.

V. Chapter Five - Conclusions

A. Are the existing taxonomic systems for Western Canada adequate?

The author did reassign Pot 1 from Clearwater Lake Punctate type to SBW based on the available taxonomic descriptions from Hlady (1971) and Byrne (1973). A reorganization of both the CLP and SBW descriptions in a schematic form facilitated their use (See Tables 4 and 5). There are some difficulties in using the taxonomic systems as they are currently defined.

One point of confusion is in the definition and identification of surface finish. It would be a worthwhile endeavor to standardize the descriptions assigned to surface finishes. This standardization requires criteria to describe surface marks resulting from the manner in which a surface impression was made and with what implement. Illustrations, either plates or well-executed drawings, of good examples of each surface finish type are also required. In this thesis, high quality photocopied reproductions of comparative surface finishes of SBW (Byrne 1973) accompanied the explanation of the similarities and differences between SBW and Pot 1 (Plate 2).

The author feels that the current typologies should be reorganized and expanded to include explicit information on forming procedure and other aspects of technology. It is recognized that each assemblage has limitations of condition

and size, and may not be conducive to all the analyses outlined for Pot 1. At the very least, explicitly technological attributes will provide additional comparative data to detect similarity or difference between samples. On a higher level of expectation, technical practices can be compared on a one-to-one basis to determine if motor pattern habits (after Arnold 1985) of the individual potters were the same.

B. How could identification and recording of manufacture techniques improve the quality of data available from ceramics?

One potential improvement in the quality of the data is in the area of archaeological and historic group ethnic identification. Identification and recording of manufacture techniques would enable analysts to compare behavioral patterns as evidenced by technical practices rather than by stylistic patterns.

Secondly, knowledge of the techniques most likely used in the manufacture of a vessel or group of vessels can aid in evaluating on what level of interpretation a trait should be used. For instance, an angular, pointed shoulder shape involves a technical decision to achieve that shape in preference to a rounded shoulder continuous with the lines of the vessel. This decision for an angular shoulder represents a conscious action on the part of the potter; and the action might reflect the normal behavior for a specific

group of potters. In contrast, an impression of a thumb on the rim of a vessel might have resulted accidentally from lifting or moving the vessel while still plastic or wet. The thumbprint indicates a step in the manufacture sequence, but more as a byproduct of the technical process. It cannot be seen as a reflection of a cultural norm. Traits such as punctates or dentate markings were intentionally or consciously applied to ceramics; and because they recur in recognizable patterns, they are considered decorative and are recognized for their value in tracing historic cultural connections.

C. Was Pot 1 made on Black Fox Island?

There is no evidence to indicate that Pot 1 was manufactured on Black Fox Island (rejection of Hypothesis 1). In order to prove that the manufacture of Pot 1 was local to BFI, signs of pottery production (kiln or firing evidence, raw materials storage, tools), or the clay source, or both, would have been found on Black Fox Island. It is now hypothesized that Pot 1 was made elsewhere in the Lac La Biche region (Hypothesis A); or outside the Lac La Biche region, possibly in southern Alberta (Hypothesis B).

With further research activities in the southern boreal forest focused on the recovery of ceramics, it would be possible to determine whether or not north-central Alberta had an indigenous pottery industry. Based on the small size of the pottery sample and the lack of time continuum data,

the author concludes that, if an indigenous ceramics industry was present in north-central Alberta, it was not as prevalent nor as well-established as that of southern Alberta or boreal forest and parkland regions of Saskatchewan. More data are required to investigate this situation.

D. The role of technical analysis in the study of the Black Fox Island ceramics

Technical analysis can be used to answer questions which cannot be answered using only data on surface appearance and form. Analysis related to materials and methods used in manufacture of artifacts provides a data base which goes beyond surficial information. A consistent approach to technical analysis of pottery has been proposed (Shepard 1976), but analyses of the method and means of manufacture have often been perfunctory or ignored. Paste description incorporated into archaeological description of pottery specimens is not an adequate technical analysis of pottery, although it is a beginning.

A determination of materials used and method of manufacture of pottery has been further advocated not only to reduce subjectivity in the study of pottery, but to understand the processes involved in the making of ceramics (Sternquist 1972:72-73; Rye 1981:2-3). Knowledge of which materials were used and the techniques used in manufacture adds to an understanding of the mechanical behavior used in

pottery manufacture which may reflect or influence cultural or idiosyncratic behavior of the potter.

Chemical and mineralogical analyses of clays and pottery from Black Fox Island provide the means to identify the materials source of the pottery. Stylistic and even other physical data (paste, surface finish, color) cannot empirically identify the source as can the chemical and mineralogical data. In the study of the Black Fox Island ceramics, identification of the clay source for manufacture of Pots 1 (and 2) became an important part of the interpretation of cultural process and culture history of site GfPa-32.

The difference between the untested hypothesis implying that Saskatchewan Basin Ware style pottery was manufactured on Black Fox Island of clay local to the Lac La Biche region (Hypothesis A); and the untested hypothesis in which Saskatchewan basin ware style pottery was manufactured elsewhere, and transported to Lac La Biche (Hypothesis B), is of obvious significance to the interpretation of site GfPa-32. They involve different processes and behavior.

Information related to materials identification may also indicate the level of technological expertise, or skill, achieved with regard to pottery manufacture. A prehistoric potter's understanding of the properties of materials for ceramics manufacture is indicated by how the materials, clay and temper, were combined, molded and fired, and how the resulting product was used. Success in the

manufacture of pottery will be somewhat arbitrarily or subjectively defined if the criteria of shape, size, and decoration only are used to evaluate the success.

If technical success is defined in terms of achievement of an item which optimally carries out its intended function, a somewhat more objective evaluation may be made of expertise or skill. This approach may aid archaeological interpretation of skill or success in manufacture, even while lacking the manufacturer's own definition of success which can sometimes be obtained in ethnographic studies of potters.

The objective of the chemical and mineralogical analyses of Black Fox Island clays and pottery was, ultimately, to propose a scenario of cultural process connected to the prehistoric habitation and use of the island. By reconstructing the probable sequence of events preceding the deposition of Pot 1 on Black Fox Island, an interpretation of who was on the site, when, why, and how long would be aided. That is not to say that all these questions will be completely answered, but data to help arrive at the solutions should result from the technical analysis of the ceramics.

Table 1 - Raw data to reconstruct vessel formation processes

	Pot 1	Late variant SBW (Classes A and M).	CLP
A. MATERIALS PROCUREMENT AND PREPARATION			
1. Mineralogy/temper	Crushed granitic rock; small to occasional large quartz and feldspar.	Crushed granitic rock (quartz and feldspar).	Fine to medium sand or grit; med. to coarse crushed granite.
2. Chemical data (clay)	See Table 6.	No data.	See Table 6.
B. PRIMARY FORMING DATA			
interior	Striations, incised line, discontinous ridges. Incised and pressed thin lines.	Smooth w/ horizontal stria (Class M). Anvil marks(Class A).	Smooth w/striations. Shallow depressions.
exterior	Fabric impression-untrunc.	Cord or fabric impress.	Trunc. Fabric/cord imp.
Breakage/fracture	Laminar fracture. Small, shallow surface cracks.	Occas. laminar frac. Blockiness; coil break?	Star-shaped cracks. Occas. laminar frac. Spalling.
Wall thickness	Average ca. 10 mm. Range 9- 15 mm.	Average 7/9 mm. Range 2 - 15 mm.	Average 7.5 mm. Range 2 - 15 mm.
Vessel size and shape	Rim diameter 15 cm. Shape suspected round/ globular.	Rim diameter ca. 20 cm. Rounded body/base.	Rim diameter 17 - 20 cm. Globular w/rounded base.
C. SECONDARY FORMING DATA Surface marks	Punctates. Basses scraped. Lip edge impressions. Anvil marks. Sporadic truncation.	Punctates, single and double rows. Cord-wrapped stick, narrow lines & finger impres.	Punctates. Truncation of surface finish.
Orientation of voids and inclusions	Elongated, parallel voids; laminar compaction of paste.	Laminar compaction of paste; well-compacted.	Laminar compaction of paste.
Lip shape	Irregularly thickened.	Thickened & flattened.	Flattened and squared.

Table 2 - Key to elements used for INAA

Element	Radionuclide produced	Half-life
Arsenic	As-76	26.4 hr.
Barium	Ba-131	11.5 da.
Cerium	Ce-141	33.1 da
Cobalt	Co-60	5.26 yr.
Chromium	Cr-51	27.8 da.
Cesium	Ce-134	2.07 yr.
Dysprosium	Dy-165	139 min.
Europium	Eu-152m	9.3 hr.
	Eu-154	16 yr.
Iron	Fe-59	45.1 da.
Hafnium	Hf-181	44.6 da.
Potassium	K-42	12.52 hr.
Lanthanum	La-140	40.3 hr.
Lutetium	Lu-177	6.8 da.
Manganese	Mn-56	2.58 hr.
Sodium	Na-24	15.02 hr.
Rubidium	Rb-68	18.66 da.
Antimony	Sb-122	2.68 da.
	Sb-124	60.4 da.
Scandium	Sc-46	83.8 da.
Samarium	Sm-153	46.8 hr.
Tantalum	Ta-182	115 da.
Thorium	Th-234	24.1 da.
Uranium	U-239	23.5 min.

After DeSoete, et.al. 1972.

Table 3: Element quantities of Pot 1 and Clays 1,2,3

RESULTS OF INAA OF POT SHERDS AND CLAYS.

	Pot Sherd (n=4)	Clay #1 (n=2)	Clay #2 (n=2)	Clay #3 (n=2)
La	30.8 ± 2.0	33.5 ± 0.1	37.6 ± 0.2	39.2 ± 0.4
Ce	62.9 ± 3.0	62.4 ± 1.2	72.1 ± 2.4	76.9 ± 1.4
Sm	4.45 ± 0.22	6.43 ± 0.06	6.94 ± 0.20	7.36 ± 0.06
Eu	0.758 ± 0.024	1.32 ± 0.06	1.23 ± 0.06	1.38 ± 0.05
Dy	2.74 ± 0.51	4.59 ± 0.19	5.13 ± 0.21	5.19 ± 0.27
Lu	0.250 ± 0.010	0.420 ± 0.008	0.464 ± 0.030	0.464 ± 0.022
U	1.88 ± 0.06	3.43 ± 0.19	2.68 ± 0.17	3.36 ± 0.18
Th	10.5 ± 0.5	9.78 ± 0.31	10.6 ± 0.6	11.6 ± 0.4
K	2.11 ± 0.55	2.58 ± 0.60	1.66 ± 0.24	2.08 ± 0.06
Ba	806 ± 108	1240 ± 10	750 ± 50	598 ± 48
Rb	83 ± 1	127 ± 3	80 ± 14	113 ± 7
Cs	3.44 ± 0.58	7.46 ± 0.39	4.01 ± 0.06	5.04 ± 0.20
Hf	5.62 ± 0.57	4.48 ± 0.03	7.75 ± 0.03	5.23 ± 0.07
Ta	0.88 ± 0.05	1.11 ± 0.04	1.06 ± 0.13	1.43 ± 0.09
Sc	11.1 ± 0.1	18.6 ± 0.7	11.6 ± 0.3	13.9 ± 0.3
Co	11.2 ± 0.6	18.1 ± 1.0	13.1 ± 0.15	13.7 ± 0.2
Cr	115 ± 5	196 ± 10	108 ± 8	132 ± 1
Sb	0.64 ± 0.02	1.28 ± 0.04	0.82 ± 0.08	0.82 ± 0.02
Fe	3.31 ± 0.05	4.75 ± 0.02	3.76 ± 0.04	4.02 ± 0.05
Na	0.881 ± 0.013	0.563 ± 0.008	0.676 ± 0.015	0.598 ± 0.0
Mn	628 ± 94	472 ± 7	542 ± 5	449 ± 13
As	5.06 ± 0.65	15.5 ± 0.2	18.5 ± 2.9	10.9 ± 0.1

(K, Na and Fe in percent, all other elements in parts per million, uncertainties of 1 standard deviation)

Table 4 - Statistical comparisons between selected samples.

Element* n=11	Pot A n=12		Clay 1 n=3		F-Test statistic/significance	Student t-Test statistic/significance	Hypothesis accepted
	$\bar{X}$	S^2(var)	$\bar{X}$	S^2(var)			
Sm	4.32	0.115	6.38	0.132-1	8.71/.1075	-10.10/.0000	H1
Eu	0.79	0.939-2	1.32	0.360-2	2.61/.3096	-8.86/.0000	H1
U	1.57	0.112	3.37	0.457-1	2.44/.3261	-8.76/.0000	H1
Th	10.48	1.189	9.72	0.113	10.50/.0901	1.17/.2648	P
Ta	0.96	0.947-2	1.08	0.373-2	2.54/.3167	-2.09/.0569	HO
Sc	11.23	0.984-1	18.50	0.490	4.98/.0289	-28.30/.0000	P
Co	11.13	0.800	17.83	1.213	1.52/.2619	-11.80/.0000	H1
Sb	0.64	0.320-1	1.31	0.493-2	6.49/.1410	-6.22/.0000	H1
Fe	3.38	0.118-1	4.71	0.123-2	9.54/.0986	-20.56/.0000	P
Na	0.88	0.705-3	0.56	0.863-4	8.17/.1140	20.27/.0000	H1
As	5.01	1.783	15.70	0.130	13.72/.0699	-13.40/.0000	P

Total: H1 = 6, HO = 1, P = 4
Conclusion: The hypothesis is accepted, i.e., Pot A can be differentiated from Clay 1.

Table 4 (continued)

Element* n=11	Pot B n=6 $\bar{X}$	S^2(var)	Clay 4 n=6 $\bar{X}$	S^2(var)	F-Test statistic/significance	Student t-Test statistic/significance	Hypothesis accepted
Sm	5.87	0.163	5.29	0.235	1.45/.3480	2.23/.0497	HO
Eu	1.09	0.327-2	0.92	0.530-1	16.23/.0041	1.82/.0992	P
U	2.33	0.190	2.30	0.317-1	6.01/.0356	0.12/.9058	P
Th	9.88	0.545	8.98	1.058	1.94/.2422	1.73/.1146	HO
Ta	0.80	0.135-1	1.13	0.241-1	1.78/.2705	-4.21/.0018	H1
Sc	10.47	0.187-1	10.31	0.923	49.44/.0003	0.39/.7038	P
Co	9.76	0.202	9.38	1.446	7.14/.0250	0.72/.4869	P
Sb	1.45	0.502-1	0.85	0.660-1	1.32/.3852	4.29/.0016	H1
Fe	2.94	0.796-2	3.23	0.382-1	4.80/.0550	-3.34/.0074	P
Na	1.00	0.240-2	0.55	0.290-3	8.27/.0184	21.45/.0000	P
As	11.92	1.210	11.57	5.479	4.53/.0615	0.33/.7483	P

Total: H1 = 2, HO = 2, P = 7
Conclusion: The results are indeterminate for the Pot B and Clay 4 relationship.

Table 4 (continued)

Element* n=11	Clay 4 n=6 $\bar{X}$	Clay 4 n=6 S^2(var)	Clay 2 n=3 $\bar{X}$	Clay 2 n=3 S^2(var)	F-Test statistic / significance	Student t-Test statistic / significance	Hypothesis accepted
Sm	5.29	0.235	6.94	0.400-1	5.88/.1517	-5.51/.0009	H1
Eu	0.92	0.530-1	1.24	0.343-2	15.44/.0620	-2.36/.0506	P
U	2.30	0.317-1	2.54	0.182-1	1.74/.4045	-2.05/.0796	HO
Th	8.98	1.058	10.42	0.457	2.32/.3285	-2.16/.0673	HO
Ta	1.13	0.241-1	1.10	0.225-1	1.07/.5460	-.276/.7906	HO
Sc	10.31	0.923	11.40	0.210	4.40/.1957	-1.82/.1124	HO
Co	9.38	1.446	-12.80	0.210	6.88/.1317	-4.63/.0024	H1
Sb	0.85	0.660-1	0.85	0.973-2	6.78/.1334	-.263-15/1.000	HO
Fe	3.23	0.382-1	3.60	0.226-1	1.69/.4122	-2.85/.0248	HO
Na	0.55	0.290-3	0.67	0.252-3	1.15/.5254	-10.47/.0000	H1
As	11.67	5.479	11.17	1.263	4.34/.1979	.275/.7914	HO

Total: H1 = 3, HO = 7, P = 1
Conclusion: The null hypothesis is accepted, i.e., Clay 4 is not differentiated from Clay 2.

* Sm - Samarium
Eu - Europium
U - Uranium
Th - Thorium
Ta - Tantalum
Sc - Scandium
Co - Cobalt
Sb - Antimony
Fe - Iron
Na - Sodium
As - Arsenic

Table 5. Mineral identifications of clay and pottery samples.

Sample Number	SIZE RANGES OF MINERALS >1.0 mm	<1.0 - 0.5 mm	<0.5 - 0.2 mm	<0.2 - 0.1 mm	<0.1 mm	Comments
32-911 Pot A	NIL	An unknown quantity of subrounded to rounded quartz; a few subrounded to rounded feldspar.	2 rounded sedimentary rock, possible chert; 1 angular orthoclase fragment.	Abundant rounded quartz; a few subangular feldspar fragments.	1 chlorite, 1 rounded amphibole, 1 plagioclase; a few subrounded and subangular quartz and feldspar.	Rare biotite laths present.
32-910 Pot A	NIL	NIL	A few subrounded to subangular quartz fragments.	A few subrounded quartz and feldspar; 1 chlorite frag.; some chert; 1 subrounded amphibole.	Unknown quantity of angular and subangular quartz and feldspar, 1 muscovite.	N/C
32-935 Pot A	1 large frag. biotite plus a heavily altered plagioclase and quartz fragment.	Abundant and subrounded quartz; abundant angular feldspar.	NIL	NIL	A large quantity of predominantly angular and some subrounded quartz; 1 small chert.	N/C
32-89 Pot A	2 plagioclase and quartz grains.	2 large rounded quartz fragments; 1 angular plagioclase fragment.	Rounded subangular quartz; some feldspar; 1 possible quartzite fragment; 1 piece of chert.	Relatively angular, plus a few rounded, quartz and feldspar fragments; 2 pieces of biotite with amphibole attached.		N/C
32-912 Pot A	NIL	1 angular microcline and quartz grain; Several subrounded quartz, 1 rounded plagioclase.	Subangular quart and feldspar.		Frequent predominantly angular subrounded quartz and feldspar.	N/C
41-3 Pot B	Angular granitic rock fragments.	1 rounded quartz.	Occasional angular feldspar.	Small black possible organic or clay "chunks"; plagioclase; rounded chert.	Angular, subrounded probable quartz and feldspar.	N/C
3 C Clay 3	NIL	NIL	Rare very altered feldspar.	Minerals too small for identification.		N/C
2 B Clay 2	NIL	NIL	NIL	Very abundant 1 mm quartz with feldspar.	NIL	This clay appears very different from the other clays; similar to pottery matrices.
1 C Clay 1	Feldspar fragments altered to clay.	Rare rounded quartz.	NIL	NIL	Predominantly angular and subangular quartz and feldspar (a few subrounded); muscovite.	N/C

Table 6 - Chemical-elemental data for Pot 1 and PhNa-10:29

Pot 1	Sm	Eu	U	Th	Ta	Sc	Co	Sb	Fe	Na	As
A	14.45	0.700	1.85	9.59	0.88	11.10	12.90	0.60	3.17	0.863	6.60
B	15.06	0.807	2.00	11.80	1.02	11.40	11.40	0.63	3.39	0.918	5.15
C	14.03	0.736	1.79	9.78	0.80	10.90	10.40	0.69	3.29	0.866	3.44
D	14.27	0.788	0.93	11.00	0.81	11.20	10.30	0.64	3.41	0.878	5.07
A1	14.15	0.830	1.48	9.47	0.91	11.30	11.20	0.73	3.45	0.858	7.38
B1	14.53	0.896	1.82	10.60	1.04	11.40	10.30	0.50	3.46	0.903	4.74
C1	14.23	0.771	1.35	10.50	1.03	11.70	11.50	0.95	3.56	0.841	3.08
D1	14.10	0.696	1.45	9.60	0.94	10.80	9.84	0.66	3.32	0.929	5.79
A2	14.19	0.757	1.27	10.20	1.01	11.20	11.40	0.49	3.39	0.877	6.31
B2	14.83	1.025	1.89	13.20	1.13	11.80	12.40	0.60	3.49	0.910	4.91
C2	13.93	0.679	1.80	10.10	0.98	10.90	11.20	0.93	3.33	0.877	3.72
D2	14.08	0.828	1.21	9.89	0.95	11.00	10.70	0.30	3.26	0.895	3.91

Table 6, continued.

FhNa-10:29	Sm	Eu	U	Th	Ta	Sc	Co	Sb	Fe	Na	As
1	26.16	0.731	2.23	17.10	-1.0	10.10	19.00	0.835	3.60	0.736	7.48
2	25.94	0.681	2.58	14.40	-1.0	10.70	19.80	0.698	3.73	0.938	8.39
3	25.51	0.735	2.79	15.60	-1.0	10.30	19.30	0.832	3.71	0.897	8.49
4	26.19	0.953	3.23	15.00	-1.0	10.40	31.50	0.878	3.66	0.947	10.20
5	25.88	0.793	2.47	15.68	-1.0	9.54	14.47	0.650	3.24	0.975	8.14
6A	25.92	0.651	3.15	14.50	-1.0	11.10	22.60	0.904	3.81	0.989	7.56
6B	26.21	0.460	2.31	17.30	-1.0	11.10	23.30	0.902	3.75	0.959	8.53
6C	25.69	0.574	3.52	14.30	-1.0	10.90	22.90	0.799	3.79	0.941	8.37
6D	26.28	0.242	3.39	16.00	-1.0	10.90	23.00	0.894	3.78	0.960	8.84
7	25.85	0.817	2.76	16.30	-1.0	11.10	17.80	0.917	3.84	0.974	9.06
8	25.27	0.708	2.93	12.40	-1.0	11.20	15.80	0.938	3.78	0.923	8.63
9	25.55	0.739	3.17	13.30	-1.0	10.70	16.50	0.865	3.52	0.920	8.75
10	26.52	0.846	2.57	18.10	-1.0	10.90	20.10	0.943	3.74	1.020	7.88

Element quantities in ppm.

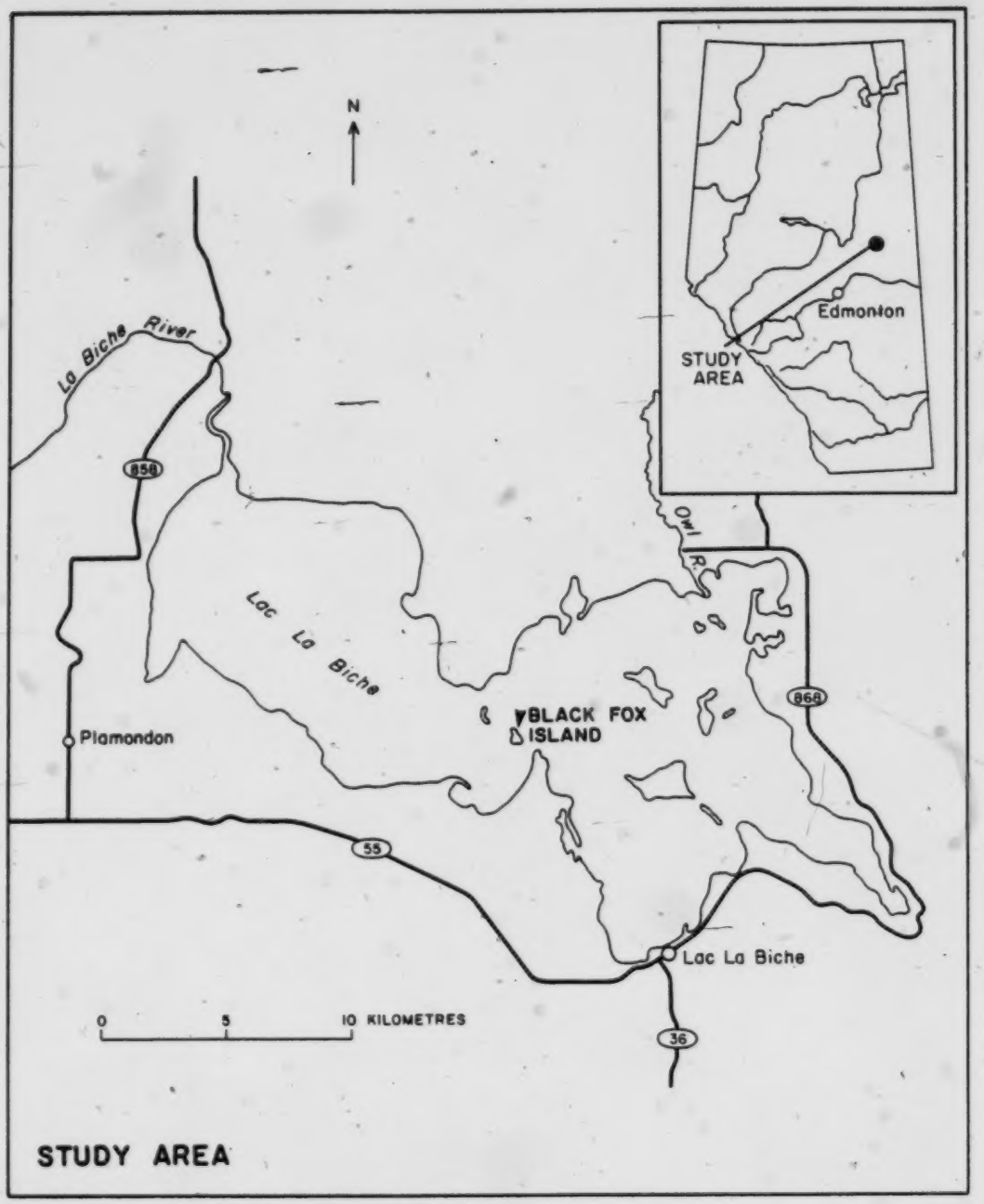


Figure 1: Location of Black Fox Island project.

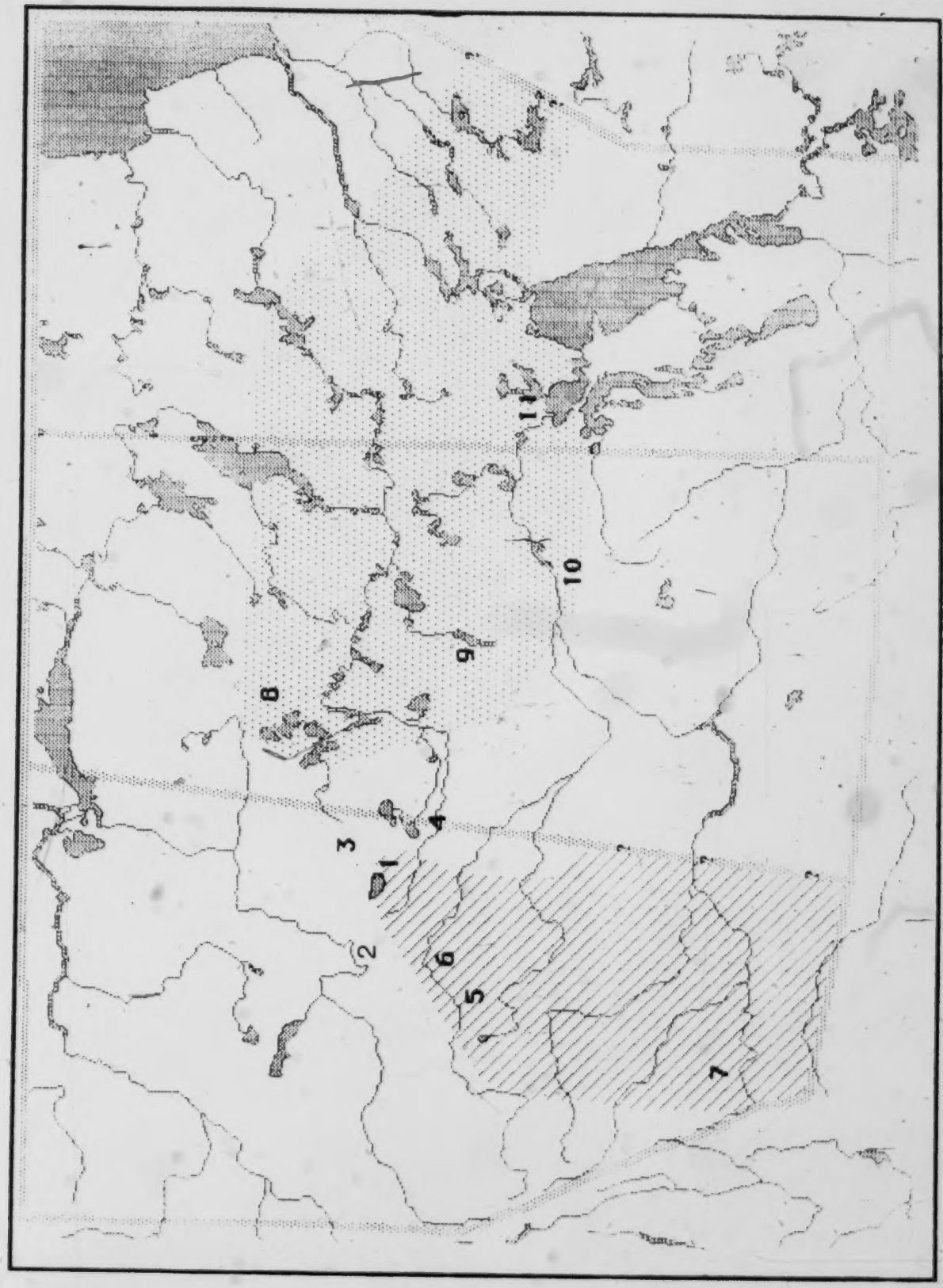


Figure 2: Pottery distributions in Alberta, Saskatchewan and Manitoba

Figure 2, cont.

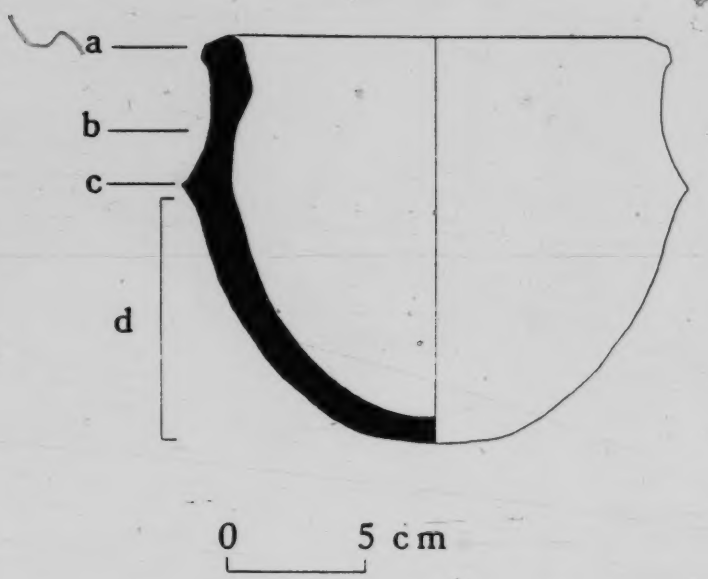
KEY

Site locations:

1. Black Fox Island, Lac La Biche
2. Calling Lake
3. Wappau Lake
4. Cold Lake Provincial Park
5. Strathcona Science Park
6. Ft. Saskatchewan
7. Morkin Site
8. Black Lake
9. Montreal Lake
10. Nipawin - Bushfield West
11. Clearwater Lake Site

Approximate known range of CLP ceramics

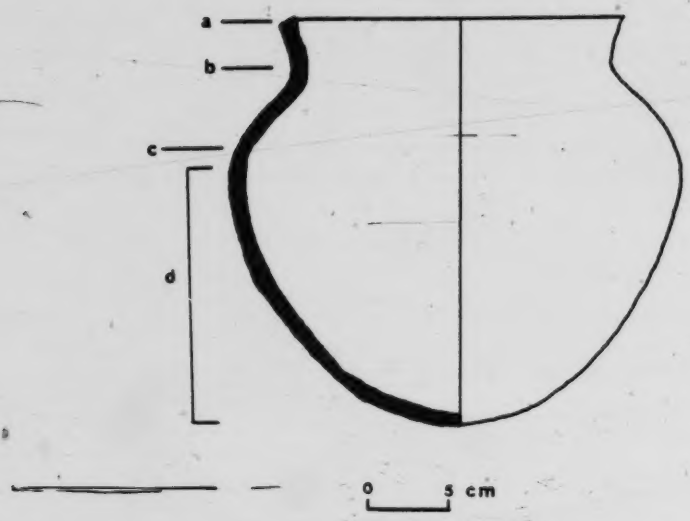
Approximate known range of SBC Late Variant ceramics



Surface finish and decoration:
Fabric-impressed exterior surface, untruncated.
Smoothed interior surface.
One row of round punctates on rimsherds.

Vessel form:
a. Lip - Flattened, with a discontinuous ridge where the lip meets the neck exterior. Thickened in some places.
b. Neck - Slightly concave.
c. Shoulder - Sharply angular, thickened (to 15 mm).
d. Body/base - Fairly uniform thickness, ca.10 mm.
Some bodysherds curved.
Wall thickness - Average 10 mm.
Range 9- 15 mm.

Figure 3: Schematic reconstruction of Pot 1.

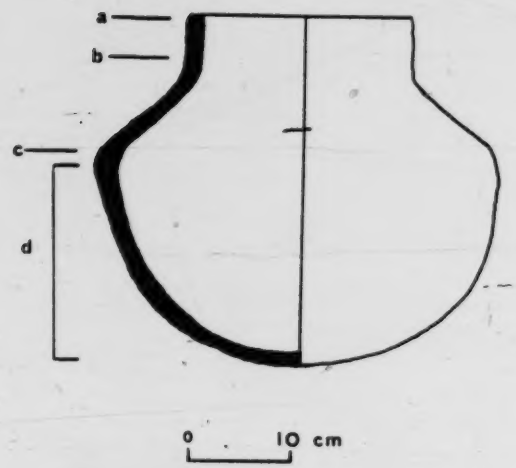


Adapted from Hanna, 1983b

Surface finish and decoration:
Truncated fabric-impressed exterior surface.
Smoothed interior surface.
One row of round punctates on rimsherds.

Vessel form:
a. Lip - Flattened.
b. Neck - Usually slightly concave.
c. Shoulder - Rounded, gradually convex or curving outward.
d. Body/base - Typically a rounded base; some bases flattened.
Wall thickness - Average 7.5 mm.
Usual range 4 - 11 mm. Can extend to 2 - 15 mm.

Figure 4: Schematic representation of CLP vessel.



Adapted from Byrne, 1973

Surface finish and decoration:
Fabric or cord-impressed exterior surface, sometimes truncated.
Smoothed interior surface.
Some vessels one row of round punctates or rimsherds.
(Punctate decoration can vary).

Vessel form:
a. Lip - Flat, thickened.
b. Neck - Usually concave.
c. Shoulder - Ridged, thickened.
d. Body/base - Globular body with a tendency to elongation; rounded or flat base.
Wall thickness - Usually 6 - 15 mm.

Figure 5: Schematic representation of SBC vessel.

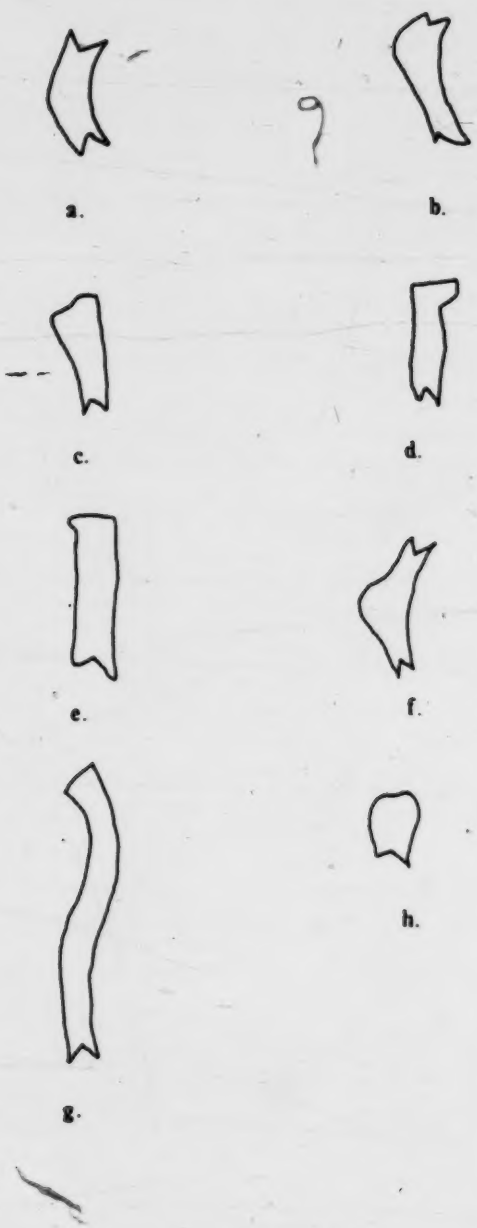


Figure 6: Saskatchewan Basin ware cross-sections. a. As1; b. An1; c. Ar1; d. Ar8; e. Cr3; f. Ms1; g. Mr6; h. Mr9; (Adapted from Byrne, 1973).

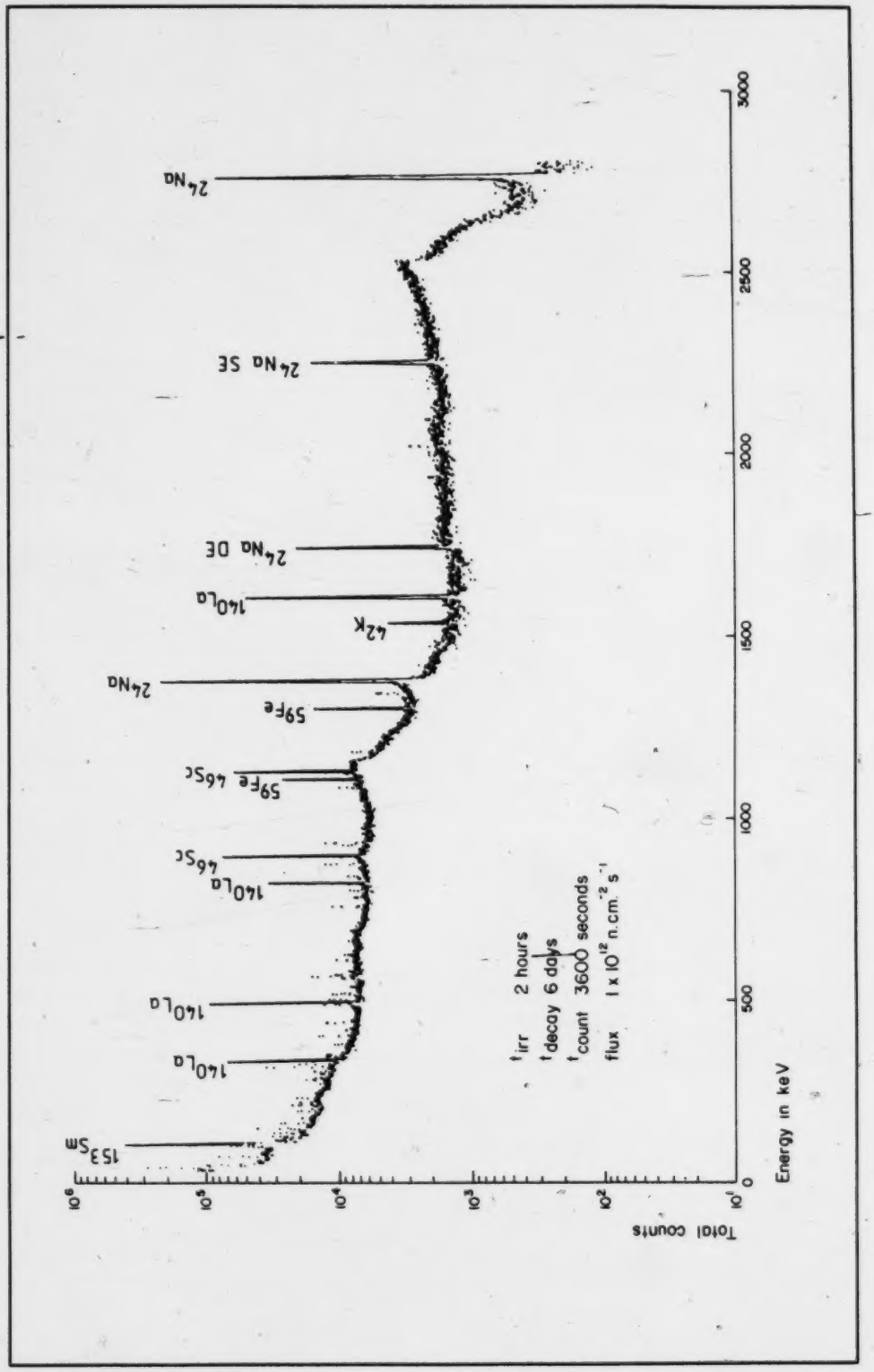


Figure 7. Example of a gamma spectrum from **Pot 1**

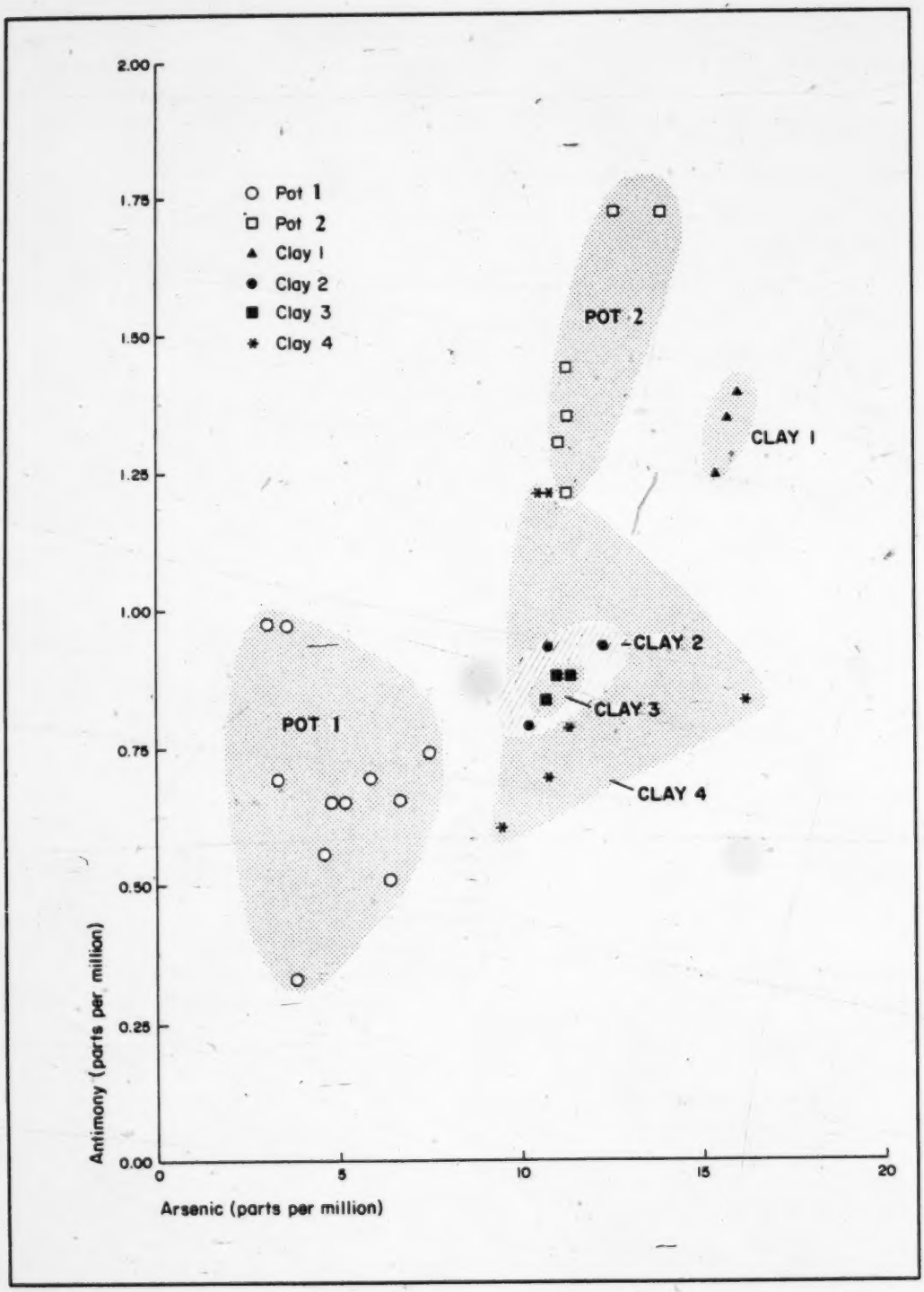


Figure 8: Scatterplot of clay and pottery samples.

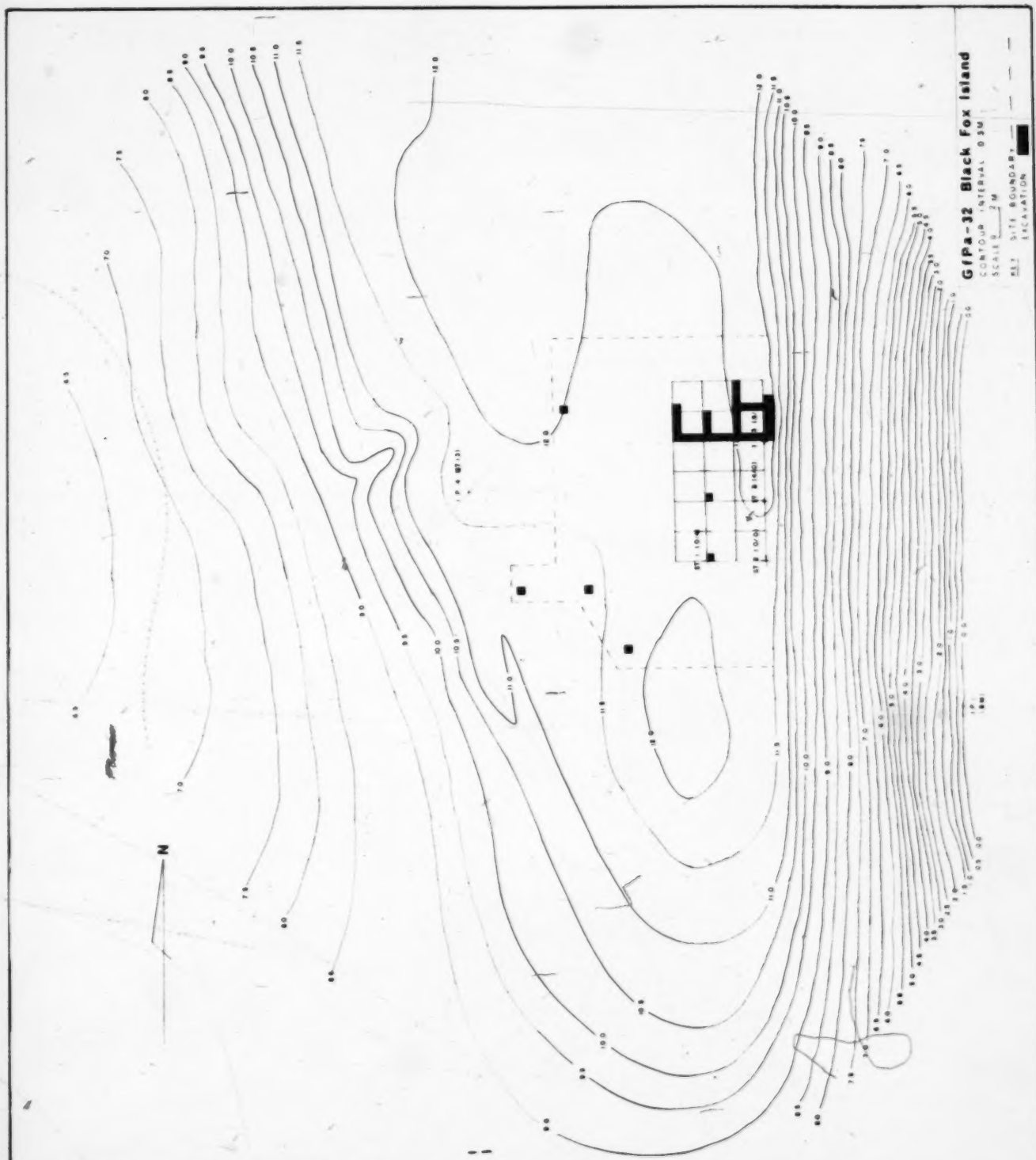


Figure 9: Site Map GfPa-32

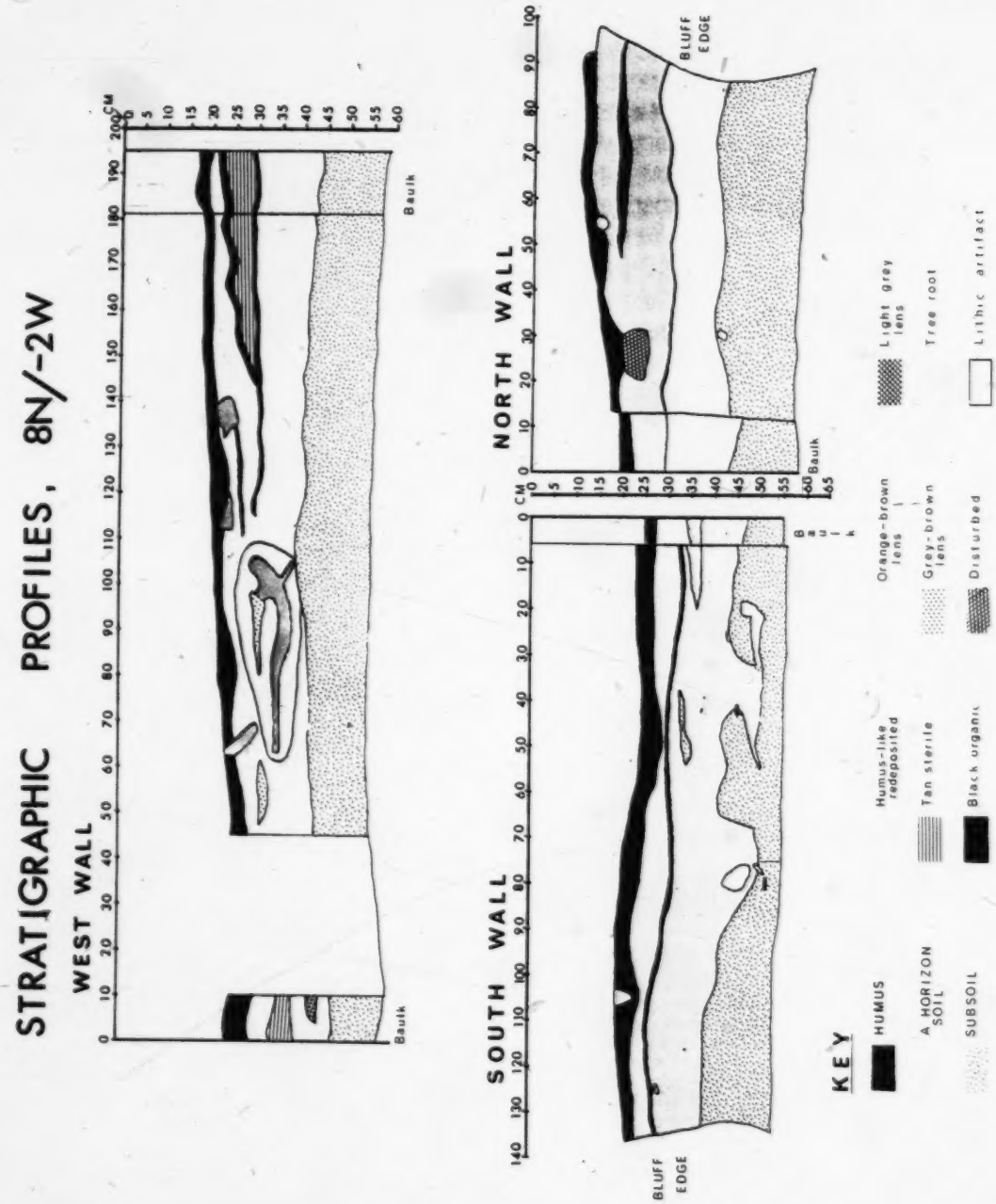


Figure 10. Stratigraphic profiles, GfPa-32.

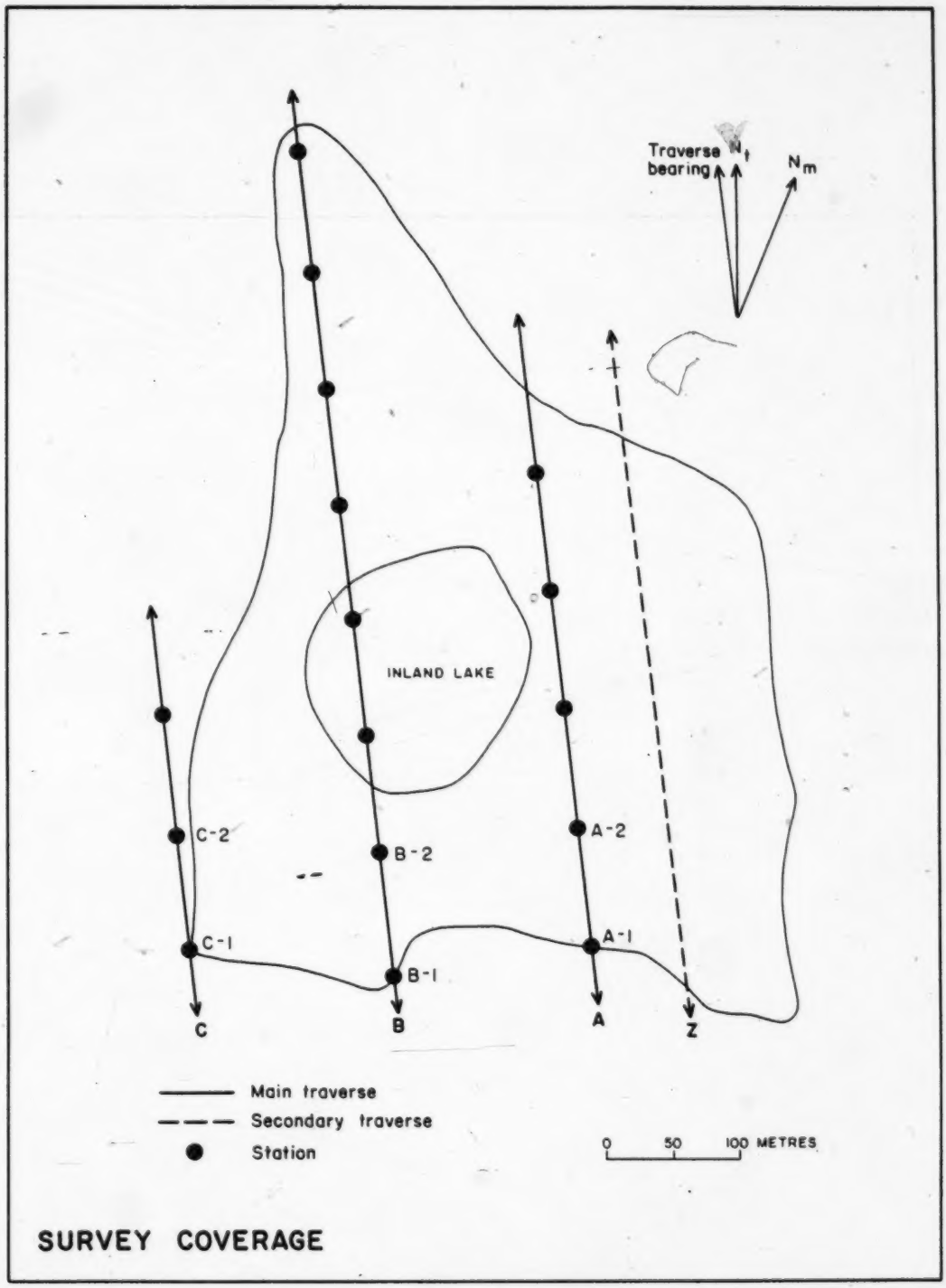
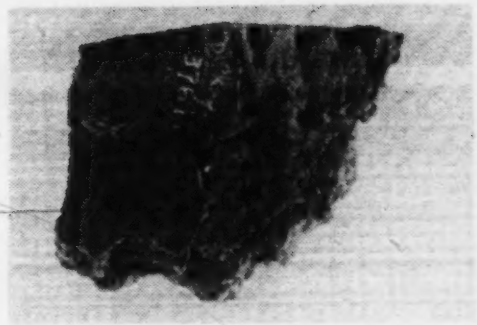
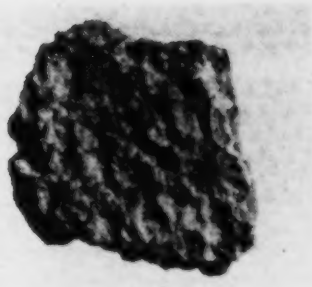


Figure 11 : Survey strategy for Black Fox Island.

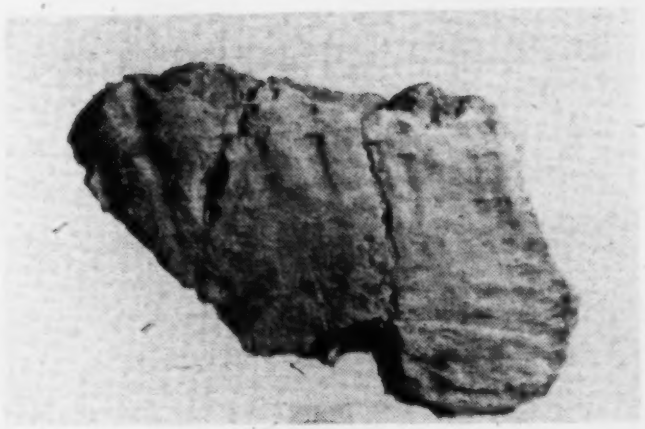
Plate 1: Reconstructed rim of Pot 1.



2a. Subclass Ar1
(Photo Byrne 1973)



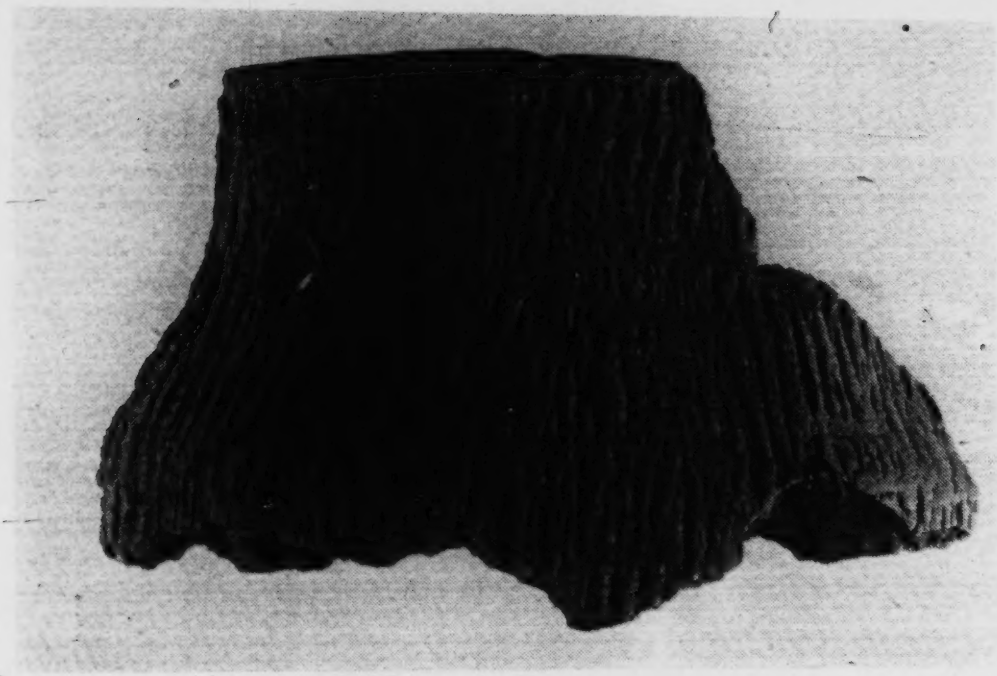
2b. Subclass Cb1
(Photo Byrne 1973)



2c. Subclass Lb1
(Photo Byrne 1973)

2d. Subclass Mb1 and
Subclass Mb2
(Photos Byrne 1973).

Plate 2: SBW and Pot 1 surface finishes.



2e. Subclass Ar25 (Photo Byrne 1973)

2f. Pot 1

Plate 2, continued.

Plate 3a: Black Fox Island, south shore.

Plate 3b: View of GfPa-32. (Site is at extreme left in photo).

Plate 4: Diagnostic artifacts, GfPa-32 a. Fabric-impressed, punctate rimsherd b.,c. Fabric-impressed shoulder sherds d.,e.,f. Small, corner-notched projectile points g., h. Oxbow points i. Unknown type point (possible McKean).

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Appendix 1: Environment of the Study Region; Fieldwork and Results of the Black Fox Island Project

Physical Environment of the Study Area

The Lac La Biche region, located about 250 km northeast of Edmonton (Figure 1), is within the topographic area of the Eastern Alberta Plains, and within the mixed wood vegetation section of the Canadian Boreal Forest Region. The climate is characterized by cold winters and short, cool summers. Lac La Biche is a shallow lake with a maximum depth of 21 metres (McCullough 1982:1-3). It is approximately 33 km at maximum length. Several islands are concentrated in the eastern portion of the lake.

Black Fox Island has topographic and vegetational features in common with the mainland, approximately one quarter mile to the south. Approximately two-thirds of the island's shoreline is an eroding bluff which, at the present time, overlooks a cobble and/or till beach. The predominant tree species on the island is poplar, with secondary species of saskatoon and dogwood trees, and willow shrubs. The island has topographic diversity, ranging from the high elevations of shoreline bluffs and several ridges and knolls in the island's interior, to low elevations around a small inland lake in the center of the island and associated swampy, low-lying terrain. Soils on the island have sand and clay components, and do not appear to be highly acidic as

was evidenced by preservation of bone in the A soil horizon (see faunal analysis, below).

The geologic characteristics of the Lac La Biche region have been adequately described by McCullough (1982:1-2). The Upper Cretaceous bedrock is overlain by Laurentide till (clay and silt). The topography of the area varies from gently rolling to rolling or hummocky terrain. Along with Lac La Biche, smaller lakes are in the region. The waterways north of the lake belong to the MacKenzie River and Arctic Ocean system, and the southern waterways belong to the Churchill River - Hudson Bay system.

Resources

The island offers diverse subsistence opportunities. At present, the sport fish capability of the lake is highly rated, and the lake yields several species. The numerous fish population is described for the early 1900s by informant reports of spawning whitefish in the strait between the mainland and Long Island, with up to 1000 fish caught per boat per night. Tradition has it that many spawning whitefish were in the lake upon the first arrival of the Indians to the lake. Black Fox Island and a nearby island were known as the "Fishing Isles" due to excellent fishing capacities (Chipeniuk 1975:12,16,18).

Canada Land Inventory and Alberta Land Inventory maps indicate that the Lac La Biche periphery is generally not conducive to ungulate or waterfowl production, but isolated

spots around the lake do have moderate to good potential. Although the waterfowl production capability of Lac La Biche is indicated as poor, the author's personal observation has shown a small, inland pond on Black Fox I. to be a haven for ducks. Other bird species are found on the island. The island is home to small mammals, including rabbits. The island is reportedly a game track for large mammals to swim and "island-hop" from one shore of the lake to another (T. Maccagno, pers. communication).

A clay source on the beach below the eastern bluff is of a quality conducive to the manufacture of ceramics. It seemed possible that this plastic, dark brown-black clay might have provided the raw material for samples of the pottery found at GfPa-32. Quartzite, the most frequently-used material of manufacture for stone tools of the Lac La Biche region, appears in ready quantity on the cobble beaches of the island. Utilization of the resources of the forested habitat around the lake's edge would have depended upon the ability of the island's inhabitants to travel to the nearest shore of the mainland, a point of land lying approximately one quarter mile from the southern shore of the island.

Modern Environment

The following information is largely derived from McCullough's (1982:2-4) description of the Lac La Biche region vegetation, fauna and climate. Lac La Biche is in the

mixed wood section of the Boreal Forest Region of Canada, where aspen, poplar, paper birch and white spruce predominate. Jackpine is evident in well-drained or fire-disturbed areas, and black spruce occurs under muskeg conditions. A number of berry species are present (blueberry, saskatoon berry, cranberry, strawberry). Saskatoon trees are prevalent on the east shore of Black Fox Island. The larger fauna consist of deer, elk, moose and bear. Reports of wood buffalo in the area are documented for the turn of the century. Small mammals include beaver, muskrat, lynx, snowshoe hare and fox. Fish are abundant in the lake, including whitefish, perch, walleye, northern pike and tullibee. The area is today commercially fished by small operators. Ducks are abundant, especially in certain marshy areas conducive to nesting.

The typical climate is described as having lowest average winter temperatures of 0° F and mean July temperatures (the hottest month) of 70° F, with northwesterly winds prevailing in spring and late summer. The area has approximately 100 frost-free days, and the mean annual precipitation (70% rain) is about 18 inches.

Additional information on the historically-known environment of Lac La Biche comes from R.C. Chipeniuk (1975). The modern ice conditions of the district are such that the shallow lakes freeze over any time from the end of October and the deep lakes by the end of December. The thickness of the ice varies from year to year. A maximum ice

thickness for Lac La Biche would be 48 inches in a cold winter. The ice usually goes out by mid May or the end of May. The best fishing is from ice-out to mid-June, when the fish are recovering from spawning and are feeding at the surface or in the shallows. Pickerel runs occur in the La Biche and Owl Rivers (Chipeniuk 1975:17).

Paleoenvironment

The recent paleoenvironmental history of the Lac La Biche region is most relevant to the Black Fox Island study. By the time of the Middle Prehistoric Period beginning ca. 5500 B.C., the southern boundary of the Boreal Forest had shifted 40 to 60 miles north of its present position (Lichti-Federovich 1970), placing Lac La Biche in the Boreal Forest-Grassland Transition Zone, or Parkland, at this time (McCullough 1982:23). The profile from Moore Lake, which is approximately 90 km southeast of Lac La Biche, shows an increase in grass pollens, and an increased frequency of fires is indicated by charcoal particles (Schweger and Habgood 1981:7). A much warmer and drier climate is thus indicated for the Southern Boreal Forest Region between 8000 and 6000 B.P. The displacement of the southern boundary of the Boreal Forest by the Parkland Belt may have lasted until ca. 4000 B.P. (Ibid.:8). This is the environment that would have been encountered by Oxbow Phase peoples in the Lac La Biche area. After 4000 B.P., due to cooler and moister conditions, the modern vegetation and climate began to be

established at Moore Lake and in the Southern Boreal Forest (Ibid.). A profile from Lofty Lake, near Boyle, Alberta (ca. 60 km southwest of Lac La Biche), was examined by Lichti-Federovich; it indicates that during the Late Prehistoric Period of ca. A.D. 200/700 to A.D. 1725, the Lac La Biche area was vegetated by a poplar, mixed wood forest similar to today's, and relatively stable. (McCullough 1982:33).

Schweger and Habgood (1981:8) state that climatic changes had a great effect on the hydrology of Alberta in general, pointing to the significant fluctuations of historic times as well as the Holocene dry period. These hydrologic variations may very possibly have had significance for the prehistoric settlement of Lac La Biche, influencing movement of people in search of a specific resource base.

Site GfPa-32

GfPa-32 is located on the eastern edge of Black Fox Island atop an eroding, high, sandy-clay bluff. The site area atop the bluff was heavily vegetated with briars and other underbrush and saskatoon trees. From the edge of the sheer bluff, the ground surface gently slopes inland to a low-lying area (see Site map, Figure 9).

Methodology

Subsurface testing of site GfPa-32 was prefaced by examination of the bluff face below it. Cultural material observed in the exposure provided a reference point around which to delimit the boundaries. Test pits 50 cm by 50 cm were sunk to the south, west and north of the bluff edge, which itself delimited the eastern site boundary. After the site boundaries were determined, an area on-site was cleared and a two-meter grid system was established for the site and staked out on the cleared area. A system of 2.0 meter by 0.5 meter trenches was planned for the excavation, and was implemented for four of the grid units (see Site map, Figure 7).

No pottery was found in the test pits or test trenches. To attain the research objective of increasing the ceramic sample from the site, the author decided to open units at the bluff edge where cultural material, including pottery, was visible. Three one-meter wide units on the bluff edge did yield pottery. All units were excavated according to observed natural soil levels, which in most cases comprised three discrete zones: humus, A-horizon and a clay subsoil. Where an occupation level or activity area was suspected, the materials were mapped as comprising a "cultural level." Trowel and screen were utilized to remove and examine the artifact-bearing humus, A-horizon and A-horizon/subsoil interface levels. A shovel-shaving and screening method was utilized when sterile subsoil was approached. The subsoil

was excavated to a level where it could be unequivocably said there was no longer cultural material, usually no deeper than 40 centimeters.

Results of fieldwork

A total of 12.15 meters^2 was excavated in the area which was finally defined as site GfPa-32 (see Site Map, Figure 2). A total of 5567 artifacts were found. Of this total, pottery sherds formed 9.94% (553 pieces); lithic specimens formed 83.12% (4628 pieces); and bone formed 6.94% (386 pieces). Diagnostic artifacts for the site include: one small, dark brown chert, corner-notched point; one small, corner-notched point of unidentified lithic material (white, grainy with high mica content); two Oxbow-type points of quartzite; one triangular point, with part of the base broken (possible McKean-type variant); and a number of ceramic vessel sherds with a textured or impressed exterior surface and punctate design.

Site GfPa-32 yielded a relatively large quantity of pottery, 553 sherds, of a size range from ca. 5.0 mm to 60 mm. The GfPa-32 sample represents the remains of one vessel. The rim, including some of the neck and shoulder, has been reconstructed. The vessel is of medium size and dark brown in color. It has a textured or impressed exterior and smoothed interior, punctated neck and angular shoulders. The sherds are relatively thick (average 10 mm), tending to split laminarly. They contain occasional large grit/temper

inclusions. Further description of the $\overline{\overline{GfPa}}$-32 pottery appears in Chapter Two.

The pottery was distributed on-site in a restricted area. The entire pottery sample, excluding the sherds found in a survey of the bluff slope, was located in unit 8N/-2W, with the exception of two sherds in the extreme south of square 10N/-2W (baulk). Within the unit, most of the pottery was found in closest proximity to the bluff edge. The western most extension of pottery within 8N/-2W was 5 cm from the west wall. However, most of the pottery, both in the south and north halves of the unit, was distributed beyond 30 cm toward the east, or bluff edge in the south half, and beyond 50 cm toward the east in the north half.

The limited provenience and small sample size of the pottery makes it difficult to say anything conclusive about pottery-using behavior on site. While the limited vessel sample and distribution may be due to the excavation strategy not having coincided with the localities of other vessel remains, the two limitations may provide 'negative' information on pottery function on-site. Some speculative ideas are a) pottery was unimportant to the site inhabitants; b) its placement was accidental and providential rather than part of an intentional site-use pattern; c) pottery was used in a limited manner for a limited function, and so forth.

While the pottery is decidedly from one vessel, the vertical distribution is not so limited as might be

expected, ranging from approximately 10 to 25 cm below surface, although mostly within the A-horizon. It appears that tree roots were responsible for pushing some of the pottery downward through the soil. Slumping at the bluff edge may have promoted movement of some pottery from its original depositional position. Therefore, it is possible that anomalies in depth of occurrence of the pottery may be explained as resulting from natural causes, although a cultural pattern of distribution may be represented.

Description of lithics

As is usual for prehistoric boreal forest sites, lithic tools and debitage comprised the largest material culture component on site GfPa-32. The 4628 lithic pieces collected included projectile points, preforms, unifaces, bifaces and cores; and numerous flakes and shatter, in addition to fire-broken rock. The majority of the lithic pieces were quartzite, of various colors and qualities. The quartzite used on-site is suspected to have been locally quarried, from quartzite pebbles on the island's beaches. Secondary quantities of chert were also present. Small red chert and black chert pebbles are locally available, but are not nearly as common as quartzite. Lithic materials were found throughout the site, in each of the test-pits, trenches and bluff face units excavated. The debitage forms included primary, secondary and tertiary decortification flakes, indicating that almost the whole lithic reduction process

was enacted on-site. The inconvenience of carrying large pebbles from the beach may have dictated that most primary reduction take place elsewhere. A lithic workshop site (GfPa-33) is located on the beach below site GfPa-32, and may have been the location of most of the initial stone-working operations.

Not surprisingly, the greatest amount of lithic material came from the most completely excavated units. In the 8N/-2W bluff edge unit, clear indication of two cultural levels was given by both the vertical distributions of lithic materials, and their associations with projectile point forms assigned to two distinct time periods. In the humus/A-horizon interface and the A-horizon soil, within the same cultural and vertical level as the pottery, quartzite debitage and tools of varied colors were associated with three small corner-notched projectile points. A small white and grey quartzite corner-notched point, 22 mm in length and 13 mm in width, was found in the humus level during screening. A second point is side-notched, manufactured of low-grade brown-grey chert, and is 26 mm long and 12 mm wide. It was found in the A-horizon soil during screening, although it is known not to have been lower than 12 cm below surface. The third small point is of a white, micaceous chert, approximately 12 mm long and 12 mm wide. The base is incomplete, but it appears to be corner-notched. This point is squatter than the other two more elongated corner-notched points. A black chert awl or drill was associated with the

small points and pottery.

At the A-horizon/subsoil interface and within the upper level of subsoil, a horizontal distribution of lithic debitage and tools, again mainly quartzite, was noted and mapped. This lithic material is associated with two quartzite Oxbow points, and one triangular quartzite point of undetermined type, possibly a McKean type-variant. The two Oxbow type variants are manufactured of quartzite, one pink and one yellow. The pink quartzite point is 35 mm long and 21 mm wide, while the yellow point is 37 mm long and 22 mm wide. They were found in proximity at the A-horizon/subsoil interface, about 33 cm below surface. The large, unidentified triangular point is of reddish quartzite. The base is broken, but it appears that the form may have had a double-'earred' base. The point is approximately 43 mm long and 22 mm wide. This point was found at a level slightly higher that the Oxbow points. See Plate 4 for diagnostic artifacts from GfPa-32.

Faunal analysis

Bone was collected from several of the test pits and from the main excavation areas of bluff edge and adjacent trenches. Bone was found in the lower humus and A-horizon, but not in the clay subsoil, even though other cultural materials continued somewhat into the upper clay subsoil level. This fact suggests that preservation conditions for bone were best in the humus and the A horizon.

Unit 8N/0W contained the bulk of the recovered faunal materials (204 fragments), distributed over three natural levels. An adjacent unit, 8N/-2W, had the next highest number of bone fragments recovered (84), distributed over two natural levels. These two proveniences may have been locations of bone-processing or food-preparation activities. Where bone fragments occur in the other units they are isolated, a distribution which seems to indicate scattering.

The assemblage of faunal materials from GfPa-32 is small in size (386 pieces); and contains, primarily, extremely fragmented portions of bone. In summary: The majority of bone fragments were assigned to a "large mammal bone fragment" designation (154 fragments), and the next largest number of fragments was assigned to the "large land mammal bone fragment" category (76 fragments). The third highest count was for the "indeterminate" category (40 fragments). Of the 18 specifically identifiable bone fragments, eight were definitely assigned to beaver (Castor canadensis) and four to snowshoe hare (Lepus americanus). Three bone fragments were identified as northern pike (Esox lucius) and three bones were from white sucker (Catostomus commersoni). The white sucker bones were likely a recent occurrence, judging from their physical appearances and stratigraphic level. Only 18 fragments were considered too fragmented to attempt identification for even a broad classification. Three bone fragments gave indications of having been "worked," or modified in some manner through

cutting, scraping or polishing.

Some of the large land mammal long bone fragments, and a number of the land mammal bone fragments exhibited an appearance indicative of a change in chemical and/or mineral composition. The condition of the bones is suggestive of a process of burning, after which mineralization or demineralization took place (J. Hourston-Wright, 1983, pers. communication). The fragmentation of this bone may have occurred as part of a cultural process (breaking or shattering of bones to obtain marrow and/or pieces of material for tools), as part of a natural process (frost, roots), or a combination of the two. Some bone fragments are calcined. Hurlburt (1977:10-11) discusses a type of breakage which may have relevance for the GfPa-32 faunal collection. Dessication fracture results from drying after burning or weathering of the bone. The fracture lines are "characteristically long, straight, fine-line cracks longitudinal to the shaft and fracturing from the cortex inwards."(Ibid.:11). If extremely dessicated, long rectangular fragments of shaft appear to break off along lines of least resistance to result in "small, stocky fragments of shaft." (Ibid.). This pattern occurs for several GfPa-32 specimens.

The Survey of Black Fox Island

A survey to determine the extent and nature of archaeological resources on Black Fox Island was implemented

as part of the Black Fox Island Project. This survey was intended to provide information about relationships (if any) between the previously-located sites of GfPa-32, GfPa-8 and GfPa-33 (McCullough 1975). Another survey objective was to detect undiscovered archaeological sites at new locations on Black Fox Island. It was hoped that locating and testing new sites would help determine the spatial, and possibly temporal, extent of occupation and utilization of the island, and how the sites were related to one another in terms of functions and/or activities.

For the methodology used for the Black Fox Island survey, and a table of the sites found during reconnaissance and their associated artifacts, see Learn 1982.

Appendix 2: Procedure to Study Forming Techniques

Step 1: Observation

a. Observation of surface marks

This step includes observation of surface finish, where appropriate.

Surface marks occur during the course of the formation process. They result from the intentional or unintentional application of pressure to the clay. The marks may be evident on the interior and/or the exterior of a vessel or sherd. Marks which appear on the surface may be unintentional, as when a grass seed is accidentally pressed into the exterior of a still-plastic vessel. The process which resulted in a particular surface mark is usually evident by the features of the mark (see Rye 1981:59-60). Analysis of the marks is facilitated by a personal knowledge of what happens when certain processes are enacted on clay.

b. Observation of breakage points, fracture marks and wall thickness

The location of breakage or fracture points of a vessel often may due to method of formation or physical characteristics of a vessel. Breakage may occur where a vessel wall changes from thick (base) to thin (upper wall); at an area where one piece of clay was joined to another, as in coiling, or application of a spout; or at any other area of structural change.

The characteristics of the fractures themselves can be related to process of manufacture. Three types of fractures are recognized by Rye (1981:60), and they were considered in looking at Pot 1. They are a)laminar fractures which can cause exfoliation of sherds, b)surface cracks and c)"normal" perpendicular fractures which result in separation of one part of a vessel from another.

At this point, variation in wall thickness can be evaluated. Some of the implications of wall thickness variation are noted in Rye (1981:60). Some observations on wall thickness will be related to vessel form, such as thickening of the lip edge or at the shoulder or base, or overall vessel shape. These observations are relevant to analysis of formation process.

c. Observation of paste, grit and orientation of inclusions

These observations may appear in a standard description of a vessel.

Paste is examined for voids (Rye 1981:61), for layering, for degree of compaction and other characteristics known or thought to indicate forming method. The grit is observed for its size range (Ibid.) and density (or amount). The orientation of all inclusions, including grit, voids, organic material and the clay particles themselves is observed using a microscope to examine a cross-section of a sherd (Rye 1981:61; Shepard 1961:184).

d. Observation of sherd color

Sherd color has been cited as a means to understand conditions of the firing process. In actuality, color of archaeological pottery samples can be misleading, in terms of reconstructing firing technique (Shepard 1961:217-220; Rye 1981:119). There are many factors besides firing conditions which contribute to color of archaeological pottery samples. Colors of sherd exterior, interior and core were noted, however, as in combination with other data they may indicate some aspects of firing technique. Less emphasis will be placed on firing process than on formation process in the comparison of inferred technologies of Pot 1 and SBW ceramics.

Step 2: Identification of means

Step 1 involves observing features of Pot 1 which may be used to explain the method of manufacture. The second step in the analysis is to identify the means by which these features occurred. The identification of means step is intended to describe, in general terms rather than specific, the action or tool used to achieve a result. In observation of surface marks, the means by which a mark was made might include pressing, dragging, brushing, cutting. The object which was used in such a fashion might have been rigid, soft, rough, smooth, rounded, angular or etc. Identification of (general) means provides the logical linkage or stepping stone from observation of features to interpretation of the

sequence of processes and reconstruction of manufacture method.

The location of breakage points is related to how a vessel was formed, as in points of jointure, folding or cutting. Location of breakage might indicate how the break occurred, whether by direct impact (blow or drop), change in temperature, etc. The type of fracture also indicates information related to vessel formation and breakage event(s).

Observation of paste, grit and orientation of inclusions may indicate how the raw materials were prepared for pottery making in addition to how they were used. If paste is uniform and grit is observed to be well-sorted and uniform in size, the materials were probably carefully prepared for use, according to specific criteria. Orientation of inclusions indicates from what direction(s) pressure was applied to the paste as the vessel was formed (Rye 1981:61).

Sherd color, especially with reference to other sherds from the same vessel, may indicate general atmospheric conditions of the firing procedure. Comparison of interior, exterior and core colors of a sherd may also indicate general firing conditions, but sherd color will not provide particulars such as temperature of firing.

Step 3: Interpretation of sequence

In order to reconstruct the method of pottery manufacture, it is critical to understand the order of events leading to manufacture of a vessel of certain form and other characteristics. Rye enumerates three main stages in the process of transforming raw materials (clay and temper) into a finished product (vessel) (1981:62). Primary forming is where the vessel is formed to the approximate shape and size specifications through a technique such as throwing, coiling, slab, pinching or molding. In secondary forming, the vessel shape is refined, or further defined, and completed. This refining of shape may be effected through beating, scraping, trimming, coiling or joining techniques. The third stage is surface modification, "to change the texture and enhance the esthetic character of the vessel." (Rye 1981:62). Sometimes, surface modification may accompany the second and especially the first stages, where a mold or parting agent is used. Surface modification usually involves decoration, or design features extraneous to function; and is done after the vessel is completely shaped. The observations of Step 1 are placed in the context of sequence of events by which those traits were formed. Rye provides an excellent discussion of primary forming techniques and the traits associated with them (1981:66-83). He does the same for secondary forming techniques (Ibid.:84-88) and decorative techniques (Ibid.:89-95). Knowledge of the necessary sequence of events used to produce a finished vessel leads to an ability to reconstruct

the process of manufacture of a vessel through examination of the archaeological remains.

Step 4: Reconstruction of process of manufacture

Once the traits related to manufacture are observed, and the means by which they were caused and the sequence in which they were caused are observed, one can attempt to reconstruct the specifics of the process of manufacture. The completeness of the resulting behavioral interpretation will depend on what traits are available for interpretation, and the depth of knowledge the analyst has of pottery manufacture. Experiments with pottery making or relevant ethnographic observation or ethnohistoric documentation, if available, can contribute to the reconstruction (see Simon 1979).

Appendix 3: Fundamentals of the SLOWPOKE II Nuclear Reactor

The SLOWPOKE reactor was developed by the Atomic Energy of Canada Limited at the beginning of the 1970s to be used at universities and hospitals for neutron activation analysis and isotope production with a minimum of supervision. The word SLOWPOKE is an acronym for *Safe LOW POwer Kritical Experiment*.

SLOWPOKE is a small pool-type reactor with a critical mass of enriched ^{235}U of approximately 0.85 kg. The small critical mass is a consequence of the beryllium annulus, bottom plate and upper shims which surround the fuel cage. Due to its low atomic mass, Be reflects a certain percentage of neutrons back into the reactor core where, once thermalized, they may participate further in the fission of ^{235}U. Utilizing the reactor a maximum thermal neutron flux of $1 \times 10^{12} n\ cm^{-2} s^{-1}$ is attainable.

The insertion or removal of a central cadmium control rod is used to control the fission process, due to the very large thermal-neutron capture cross-section of ^{113}Cd.

The University of Alberta SLOWPOKE reactor has five inner and one larger outer site for the irradiation of samples.

The U-Al alloy fuel rods are arranged so as to produce an equal, homogeneous neutron flux at each of the five inner sites. This feature is extremely important as it makes the

simultaneous irradiation of flux monitors and/or standards with samples unnecessary.

(Duke, M.J.M. 1983)